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RACT (Reasonably Available Control
Technology) for the Use of Cutback Asphalts in
Road Construction and Maintenance: Enforcement
Implications and Equipment Changes

JACA Corp., Fort Washington, PA

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RACT for the Use of Cutback Asphalts in Road Construction and Maintenance: Enforcement Implications And Equipment Changes

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16. Abstracts Enforcement implications and equipment changes resulting from the adoption of reasonably available control technology(RACT) for the use of cutback asphalt in the paving industry are evaluated. RACT, as developed by the Environmental Protection Agency, prohibits the use of cutback asphalt whenever emulsified asphalts are reasonably available and acceptable for use. Applicable regulations, as well as pre-and post-RACT cutback and emulsified asphalt use patterns are summarized for California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin. Climate and training are factors which have affected the degree to which these states have developed the use of emulsified asphalts. The only equipment change which may be required involves the asphalt pump. Significant pump changes are typically handled by the pump manufacturers.																				
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**RACT for the Use of Cutback Asphalts
In Road Construction and Maintenance:
Enforcement Implications and
Equipment Changes**

by

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Task No. 48

EPA Project Officer: Robert L. King

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EXECUTIVE SUMMARY

The objective of this study was to evaluate enforcement implications and equipment changes resulting from the adoption of reasonably available control technology (RACT) for the use of cutback asphalts in the paving industry. RACT, as developed by the Environmental Protection Agency (EPA), prohibits the use of cutback asphalts in road construction and maintenance operations whenever emulsified asphalts are reasonably available and acceptable for use. The primary benefit from this substitution is the reduction in volatile organic compound (VOC) emissions.

Eight states, which vary in climate and pre-RACT use of emulsified asphalts, were selected for study; these include California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin. For each state, RACT status was determined and pre-RACT use patterns of cutback and emulsified asphalts were evaluated. In California, Indiana, Pennsylvania, South Carolina, and Wisconsin where RACT has been implemented, post-RACT use patterns of cutback and emulsified asphalts were also evaluated.

Pre- and post-RACT patterns of success and use of asphalt emulsions have varied considerably among the states due to the caliber and the amount of training which has taken place as well as the degree to which some states have coped with adverse climatic conditions. Some states, such as Indiana, Pennsylvania, and South Carolina, have been using emulsified asphalts extensively, long before RACT was implemented, due to effective coordination between the state highway and transportation departments and the users and suppliers of emulsified asphalts. The training in states such as Missouri and Wisconsin has not offset the memories of past road failures in working

with emulsified asphalts. Consequently, these states have not fully developed the use of emulsified asphalts. In other states, such as California, Colorado, and Texas, the use of emulsified asphalts prior to RACT has been limited by unfavorable climatic conditions. Along the coast, where high humidities prevail, and in some of the mountain regions, where relatively cooler temperatures increase the rainfall frequency, the set time of emulsified asphalts can be severely delayed -- often making it impractical to use these materials on roads that must be quickly opened to traffic. Conversely, very low humidities, which are typical in some mid-western and southwestern states, decrease the set time of emulsified asphalts, making the timing of chip seal work very critical.

In general, the use of cutback asphalts continues in cold mix operations and seal coat work. Consequently, these paving categories may require enforcement, with enforcement effort being less in those states where emulsified asphalts have been used extensively with success.

The only equipment change which may be required when switching from cutback asphalts to emulsified asphalts involves the asphalt pump. Pump speeds must be reduced, clearances increased and holes drilled to provide additional lubrication; however, the holes are usually predrilled by the manufacturer.

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1.0 INTRODUCTION

1.1 Study Objectives

This study analyzes use patterns of cutback and emulsified asphalts in road construction and maintenance operations in eight states. The states have a variety of climatic conditions affecting these operations and are experiencing various levels of difficulty in implementing reasonably available control technology (RACT) for the use of cutback asphalts. Knowledge of the pre- and post-RACT use patterns in these "case study" situations will be valuable to enforcement personnel in evaluating feasibility of requests for departures from RACT. This information will also assist personnel in deciding which road construction and maintenance operations are affected by the switch to emulsified asphalts and which of these operations may require additional enforcement.

1.2 Background Information

A cutback asphalt is an asphalt cement which has been liquefied by blending it with a petroleum solvent. Various types and quantities of solvents are used to extend the curing (or hardening) time of the asphalt cement. The solvents are volatile organic compounds (VOC), precursors to ozone formation in the atmosphere. In addition, the solvents represent an energy use. In 1978 the Environmental Protection Agency (EPA) published a Control Techniques Guideline (CTG) for the use of cutback asphalts in road construction and maintenance operations which specified RACT for controlling

these VOCs. RACT prohibits the use of cutback asphalts whenever the substitution with emulsified asphalts is possible. Because an emulsified asphalt is a suspension of asphalt cement, water, an emulsifying agent, and little or no solvent, such a substitution has the potential to reduce VOC emissions and save energy.

There are three types of cutback asphalts. These include rapid curing (RC), where highly volatile naphtha or gasoline is the solvent; medium curing (MC), where the less volatile kerosene is the solvent; and slow curing (SC), where a low-to nonvolatile oil is the solvent. The cure time is a function of solvent evaporation.

Emulsified asphalts are designated by the charge of the asphalt particles induced by the manufacturing of the emulsified asphalt. In cationic emulsified asphalts, the asphalt particles are positively charged and in anionic emulsified asphalts they are negatively charged. Nonionic emulsified asphalts contain electrically-neutral particles. The terms rapid set (RS), medium set (MS), and slow set (SS) are used to further distinguish emulsified asphalts. The set time, unlike the cure time of a cutback asphalt, is a function of separation and evaporation. The asphalt and water phases separate (break) and then the water evaporates. However, it is the evaporation of water which has turned out to be the limiting factor in the use of emulsified asphalts. Temperature and humidity, as will be illustrated throughout this report, are two climatic factors which can cause the emulsified asphalt to break either too soon or not at all. The particular emulsified asphalt that is chosen depends on the type of aggregate being used.

There are basically three techniques for applying cutback and emulsified asphalts to the road surface. Asphalts can be pre-mixed with aggregate, applied as a spray application and combined with aggregate, or applied as a spray application alone (see Table 1). With the exception of prime coating

Table 1
TYPICAL USES OF CUTBACK AND EMULSIFIED ASPHALTS^a

	Cutback Asphalts ^b												Emulsified Asphalts ^c													
Uses	RC-70	RC-250	RC-800	RC-3000	MC-30	MC-70	MC-250	MC-800	MC-3000	SC-70	SC-250	SC-800	SC-3000	RS-1	RS-2	MS-1, HFMS-1	MS-2, HFMS-2	MS-2h, HFMS-2h	SS-1	SS-1h	CRS-1	CRS-2	CMS-2	CMS-2h	CSS-1	CSS-1h
<u>Aggregate and Asphalt Mixtures</u>																										
Cold-Laid Plant Mix																										
Base and Surface																										
Open-Graded																										
Dense-Graded																										
Sand		✓					✓	✓	✓		✓	✓	✓						✓	✓				✓	✓	✓
Patching, Immediate		✓					✓	✓	✓		✓	✓	✓						✓	✓				✓	✓	✓
Patching, Stockpile		✓	✓				✓	✓	✓		✓	✓	✓				✓	✓	✓				✓	✓	✓	✓
Mixed-In-Place (Road Mix)																										
Base and Surface																										
Open-Graded																										
Dense-Graded		✓	✓	✓				✓	✓		✓	✓	✓				✓	✓	✓					✓	✓	
Sand		✓	✓				✓	✓	✓		✓	✓	✓						✓	✓					✓	✓
Slurry Seal		✓	✓			✓	✓	✓	✓		✓	✓	✓						✓	✓	✓				✓	✓
<u>Aggregate and Asphalt Spray Applications</u>																										
<u>Surface Treatments</u>																										
Single		✓	✓	✓										✓	✓											
Multiple		✓	✓	✓				✓	✓					✓	✓							✓	✓			
Sandy Seal		✓	✓	✓			✓	✓	✓					✓	✓	✓						✓	✓			
Penetration Macadam																										
Base																										
Open-Graded																										
Dense-Graded		✓		✓										✓	✓							✓				
<u>Asphalt Spray Applications</u>																										
<u>Surface Treatments</u>																										
Fog Seal																										
Prime Coat-Open	✓	✓				✓	✓									✓			✓	✓					✓	✓
Prime Coat-Dense	✓	✓			✓	✓													✓	✓					✓	✓
Tack Coat	✓	✓																	✓	✓					✓	✓
Crack Filler	✓																		✓	✓					✓	✓

^aThese uses are defined in the glossary of road construction and maintenance operations in Appendix C (Section 4.3).

^bBased on the Asphalt Institute's Asphalt Surface Treatments, MS-13, 1979 (revised) and Asphalt Cold-Mix Manual, MS-14, 1977. RC, MC, and SC denote rapid cure, medium cure, and slow cure cutback asphalts, respectively. The numbers represent the lower end of the kinematic viscosity range (centistokes at 140 F) specified for each grade.

^cBased on 1979 Annual Book of ASTM Standards Part 15 (D 3628). RS, MS, and SS denote rapid set, medium set, and slow set emulsified asphalts, respectively. The letter "C" indicates cationic emulsified asphalts. "HF" indicates high float emulsified asphalts. Low viscosity grades are designated by the number "1"; higher viscosity grades by "2". The letter "h" indicates a harder base asphalt.

a dense-graded surface, it is usually possible to substitute a cutback asphalt with at least one grade of an emulsified asphalt for all uses in road construction and maintenance operations. However, the degree and quality of substitution will vary in a given area according to the methods used in constructing and maintaining roads, the prevailing weather conditions, and the extent to which work practices for the use of emulsified asphalts have been developed.

The sale of emulsified asphalts in the United States has increased over the period from 1975 through 1978, whereas the sale of cutback asphalts has been steadily decreasing since 1973. The national sales trend for each product is shown in Figure 1.

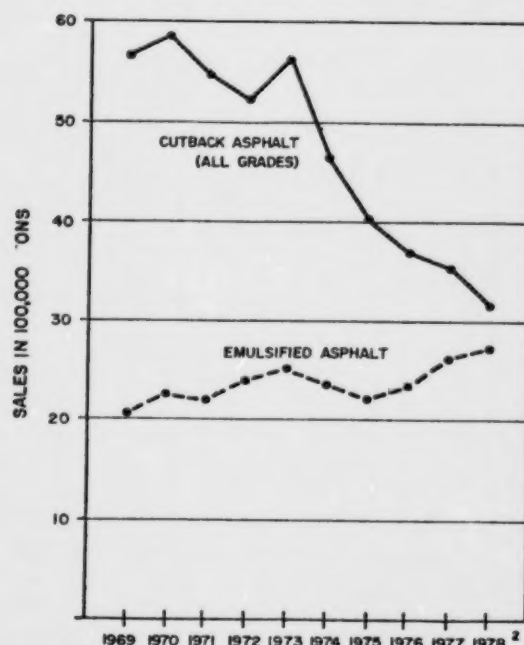


FIGURE 1. Cutback and emulsified asphalt sales in the United States¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

This relationship predates RACT and is probably attributable to two factors -- a desire by some states to reduce VOC emissions by requiring the substitution and the emphasis on repair rather than new construction. Tight road construction budgets favor surface treatments and light maintenance work rather than the construction of new roads or extensive repairs to existing roads. Consequently, emulsified asphalt surface treatments and light maintenance work have increased while cutback asphalt use in these areas has decreased.

The national trend in the use of cutback and emulsified asphalts is a composite of state-use data but does not always reflect the situation in an individual state. The patterns of some states are similar to the national pattern shown in Figure 1, while other states, with effective training programs and coordination between the users and suppliers of emulsified asphalts, have practically eliminated the use of cutback asphalts in their road construction and maintenance operations. Still other states, due to a combination of factors, have had bad experiences with emulsified asphalts and continue to predominantly use cutback asphalts. This variation among the states has prompted an investigation into the factors which affect the use of emulsified asphalts in a state and thus affect RACT implementation.

1.3 Scope of the Study

The use patterns of cutback and emulsified asphalts in road construction and maintenance operations for California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin were examined. State selection was based on preliminary discussions with representatives from the

EPA, state highway departments, and private industry. A bituminous-materials-use table was developed for each of the eight states. Each state table compares the use of cutback and emulsified asphalts in road construction and maintenance operations before and after (if applicable) the implementation of RACT in that state.

The extent to which RACT implementation has necessitated equipment changes was also examined. Contact was made with manufacturers of asphalt batch plants, continuous drum mix plants, travel plants, tank truck distributors, pavers, and other auxiliary plant and field equipment, and a summary of typical changes in equipment was developed.

1.4 Organization of the Report

An executive summary of report findings and conclusions precedes this introduction which has covered study objectives, background information, and the scope of the study.

The relative difficulty in implementing RACT in the eight states is evaluated in Section 2.0 of this report. RACT is defined, and the evaluation method used in this study is explained. For each state, the status of RACT is reviewed, and the use patterns of cutback and emulsified asphalts are estimated prior to and following RACT implementation (if applicable) in state road construction and maintenance operations. The degree of difficulty in implementing RACT is estimated and those types of road construction and maintenance operations which may require additional enforcement are noted. A summary of the eight state findings is presented at the end of this section.

In Section 3.0 a flow chart of the use of cutback and emulsified asphalts, from the point of manufacture to application, illustrates where changes in equipment may be necessary. Typical changes are then separately addressed.

State composite bituminous-materials-use tables, lists of state road construction and maintenance operations, and lists of state cutback and emulsified asphalt suppliers can be found in Section 4.0, Appendix A. In the event that the reader wants to compare climatic conditions in the states examined with conditions in states not covered in this report, temperature, humidity, and rainfall data are provided in Section 4.0, Appendix B. A glossary of road construction and maintenance operations appears in Section 4.0, Appendix C.

2.0 ENFORCEMENT IMPLICATIONS: EVALUATION OF THE RELATIVE
DIFFICULTY AMONG THE STATES IN IMPLEMENTING RACT

2.1 Defining RACT

The EPA now requires each state having one or more ozone nonattainment areas, to include RACT guidelines for the use of cutback asphalts in road construction and maintenance operations in their State Implementation Plan (SIP). The regulation usually includes the following general specifications:

- RACT implementation dates
- Exempt road construction and maintenance operations -- Prime coat applications and stockpile mixes are usually exempt; some states currently exempt the use of cutback asphalts in mix operations, tack coat applications, and dust palliative and aggregate precoat work.
- Limits on solvent contents in emulsified asphalts -- The EPA recommends two options for specifying maximum solvent contents in the following road construction and maintenance operations:

	<u>Option 1</u>
Seal coats in early spring and fall	3%
Chip seals with dusty or dirty aggregate	3%
Mixing with open-graded aggregate that is not well washed	8%
Mixing with dense-graded aggregate	12%

As an alternative, a maximum solvent content of seven percent may be specified across the board for all emulsified asphalts.

EPA allows the states some flexibility in RACT development. If a state proposes RACT which essentially conforms to the CTG requirements but wishes to include different regulatory cut points or minor source exemptions, it may still receive EPA approval. In this situation the "five percent rule" would apply; the state would first demonstrate that the emissions allowed by its proposed RACT would not be more than five percent greater than the emissions which would result from implementing the CTG. However, this equivalency provision may not be utilized to propose RACT which departs greatly from the CTG.

In urban nonattainment areas, the "five percent rule" is applied separately. As an example, one area in a state which deviates by two percent could not offset another area in that state which deviates by eight percent. They must both be within five percent. In rural nonattainment areas, however, the emissions may be averaged for equivalency demonstration purposes allowing the counties which are above the five percent limit to be offset by the counties which fall below the limit.

RACT may be applicable statewide or only in nonattainment photochemical oxidant areas of the state (that is, designated areas having ambient air ozone concentrations greater than 0.12 ppm). Some state regulations have received EPA approval (sometimes on a conditional basis), whereas others are in various stages of development and review.

2.2 Evaluation Method

The relative difficulty for California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin to implement RACT was determined by evaluating pre- and post-RACT use patterns of cutback and emulsified asphalts in road construction and maintenance operations. These states were selected because they represent a spectrum of differences in climate and pre-RACT use of emulsified asphalts. A comparison of the ranges

of mean monthly temperatures, relative humidities and rainfall for the months in which RACT is being (or is to be) implemented in each state is given in Table 2; these values are presented only as a general comparison and do not reflect extreme values in isolated areas of a given state. (The reader is referred to Appendix B, Section 4.2, for similar climatic data for states not covered in this study).

State highway specifications and RACT implementation dates were used to develop a bituminous-materials-use table for each state. The general format of the table is shown in Table 3. The table shows the use of cutback and emulsified asphalts in road construction and maintenance operations prior to RACT implementation (that is, during the past couple of years) and following RACT implementation. Evaluation of use patterns was limited to only those road construction and maintenance operations which may be affected by the switch to emulsified asphalts (as an example, emulsified asphalt slurry seal operations were not included in this study). Furthermore, no attempt was made to evaluate use patterns of cutback and emulsified asphalts resulting from regulations which will become effective after the 1980 paving season. Use estimates range from 1, which means generally used, to 5, which means never used. A value of 5, however, may indicate that the road construction or maintenance operation is not conducted in that state (by that respondent) or that it is done with other materials (such as hot-mixed or rubberized asphalt cements).

Representatives from the Asphalt Institute, state and county highway departments, paving contractors, and emulsion suppliers from each state were asked to complete the bituminous-materials-use table. The Asphalt Institute and the state highway departments were contacted first and asked for contacts at the county level and in the private sector (contractors and suppliers).

Table 2

RANGES IN MEAN MONTHLY TEMPERATURES, RELATIVE HUMIDITIES, AND RAINFALL
FOR THE MONTHS IN WHICH RACT IS BEING (OR IS TO BE) IMPLEMENTED^a

State	Months of the Year in which RACT is being (or is to be) implemented											
	January	February	March	April	May	June	July	August	September	October	November	December
California												
Temp (°F)	24-54	25-57	29-62	34-72	45-77	60-87	58-94	58-94	54-87	44-76	29-	24-56
Rel. Hum. (%)	38-82	29-82	26-80	36-81	26-81	26-81	17-81	18-80	17-81	18-81	28-83	37-91
Rainfall (in)	1.51-7.94	1.54-5.90	1.27-5.52	0.57-3.23	0.27-1.74	0.07-0.85	0.02-0.41	0.02-0.39	0.05-0.43	0.42-2.93	0.69-5.22	1.69-8.63
Colorado												
Temp (°F)					44-63	44-73	54-78	54-76	48-71			
Rel. Hum. (%)					37-62	29-63	38-63	47-72	40-63			
Rainfall (in)					1.01-2.64	0.70-2.58	1.47-2.34	1.69-2.26	1.06-1.38			
Indiana												
Temp (°F)				47-57	58-66	69-76	73-78	71-77	64-71	53-60		
Rel. Hum. (%)				66-68	67-69	72-74	66-69	69-73	69-73	68-73		
Rainfall (in)				3.31-4.17	3.73-4.50	3.94-4.66	3.21-3.53	3.01-3.48	2.98-3.52	2.53-3.39		
Missouri												
Temp (°F)					63-68	72-76	77-81	75-80	67-72			
Rel. Hum. (%)					67-72	69-73	63-68	68-73	63-71			
Rainfall (in)					3.98-5.26	3.92-5.83	3.05-3.14	3.10-4.29	3.26-4.09			
Pennsylvania												
Temp (°F)					54-63	63-72	68-77	64-78	58-67	48-56		
Rel. Hum. (%)					67-73	71-73	67-73	69-81	68-80	68-74		
Rainfall (in)					4.13-4.58	3.33-4.44	3.81-5.01	3.37-4.88	2.90-3.66	2.88-3.57		
South Carolina												
Temp (°F)			49-59	59-66	64-73	69-76	75-82	70-82	65-77	59-70	49-57	
Rel. Hum. (%)			63-71	59-71	67-72	67-73	73-81	76-81	75-81	68-80	70-73	
Rainfall (in)			3.64-6.82	2.97-5.09	3.02-5.01	3.49-4.68	5.04-7.21	4.54-7.58	3.21-4.97	2.12-4.86	2.22-4.87	
Texas												
Temp (°F)	34-62	37-63	44-68	54-76	60-83	73-85	74-88	76-87	69-83	57-78	46-67	36-61
Rel. Hum. (%)	49-82	47-81	36-73	28-80	28-81	30-74	44-81	45-78	46-80	47-74	46-72	47-81
Rainfall (in)	0.64-4.33	0.30-3.75	0.31-3.79	0.61-4.41	1.24-5.52	1.38-3.18	1.76-4.50	1.60-4.46	1.61-4.40	1.13-3.20	0.37-4.04	0.51-4.39
Wisconsin												
Temp (°F)					50-60	54-68	64-74	63-72	57-64			
Rel. Hum. (%)					66-70	68-72	68-74	73-76	68-80			
Rainfall (in)					2.71-3.73	3.83-5.10	2.90-3.99	3.01-4.01	2.95-3.68			

^aThis information has been interpolated from figures on maps in the Climate Atlas of the United States, U.S. Department of Commerce, 1968.

Table 3

GENERAL FORMAT OF STATE BITUMINOUS-MATERIALS-USE TABLE^a

Road Construction and Maintenance Operations	Pre-RACT Use		Post-RACT Use (Through 1980)			
	Cutback	Emulsified	Regulated Season		Nonregulated Season	
			Cutback	Emulsified	Cutback	Emulsified
Base Courses	—	—	—	—	—	—
Surface Courses	—	—	—	—	—	—
Slurry Seal	—	—	—	—	—	—
Fog Seal	—	—	—	—	—	—
Prime Coat	—	—	—	—	—	—
Tack Coat	—	—	—	—	—	—
Patch Material	—	—	—	—	—	—
Immediate Use	—	—	—	—	—	—
Stockpile	—	—	—	—	—	—
Paved Shoulders	—	—	—	—	—	—
Dust Palliative	—	—	—	—	—	—
Aggregate Precoat	—	—	—	—	—	—
Recycling	—	—	—	—	—	—

^awhere 1 = generally used
 2 = sometimes used
 3 = used on a selected or trial basis
 4 = currently not used but in research and development stage
 5 = never used

Therefore, sampling (that is, selection of the contacts) was based on judgment and not statistical procedures. Responses are tabulated in a composite bituminous-materials-use table for each state that has already implemented RACT in Appendix A (Section 4.1). Following a discussion of pre-RACT use patterns of cutback and emulsified asphalts, post-RACT use patterns through the 1980 paving season are summarized. In the event that RACT for a given state is to be implemented after the 1980 paving season, 1980 use patterns (pre-RACT) of cutback and emulsified asphalts are reviewed and potential enforcement problems are discussed based on current trends. Reasons for continued use of cutback asphalts in the road construction and maintenance operations which RACT does not exempt are explained so that grounds for evaluating departures from RACT can be established. The road construction and maintenance operations cited may require additional enforcement in that state.

2.3 Evaluation of Individual States

2.3.1 CALIFORNIA

2.3.1.1 RACT Status in California. "Consideration of a Model Rule for the Control of Volatile Organic Compound Emissions from Cutback Asphalt Paving Material", was released April 14, 1979 by the California Air Resources Board to all local air pollution control districts (APCD), which are designated ozone nonattainment areas, as a guideline for RACT development. As of April 14, 1980, 19 of California's 22 affected APCDs had submitted RACT to EPA for approval. The San Francisco area (located in the Bay Area Air Quality Management District), the Fresno area, and the San Bernardino area (located in the South Coast Air Quality Management District) were evaluated in this study. They represent northern, central, and southern California, respectively. Their proposed RACT's, not all of which have been federally approved, are given in Appendix A (Section 4.1.1.1).

The model rule, as developed by the authors, J.A. Pantalone and M.A. Humenny, is given below.

"1. Definitions

- a. 'Asphalt' means the dark-brown to black cementitious material (solid, semi-solid, or liquid in consistency) of which the main constituents are bitumens which occur naturally or as a residue of petroleum refining.
- b. 'Cutback asphalt' means paving grade asphalts liquefied with petroleum distillate and as further defined by American Society for Testing and Materials (ASTM) specifications as follows:

Rapid cure type: ASTM D 2028-76
Medium cure type: ASTM D 2027-76

- c. 'Dust Palliative' means any light application of liquefied asphalt (cutback or emulsified asphalt) for the express purpose of controlling loose dust.
 - d. 'Emulsified Asphalt' means any asphalt liquefied with water containing an emulsifier, either anionic or cationic.
 - e. 'Tack coat' means any application of asphalt applied to an existing surface to provide a bond between new surface and existing surface and to eliminate slippage planes where the new and existing surfaces meet.
 - f. 'Penetrating Prime Coat' means any application of asphalt to an absorptive surface to penetrate and bind the aggregate surface and/or to promote adhesion between it and the new superimposed construction. Dust palliatives or tack coats are not included.
 - g. 'Road oils' shall be synonymous with slow cure asphalts.
2. a. After July 1, 1979, no person shall cause or allow the use or application of rapid cure cutback asphalt for highway or street paving or maintenance, nor manufacture, sell, or offer for sale cutback asphalt for such use or application.
- b. After July 1, 1980, no person shall cause or allow the use or application of cutback asphalt for highway or street paving or maintenance, nor manufacture, sell, or offer for sale cutback asphalt for such use or application except as specified below:
- 1) where the cutback asphalt is to be used solely as a penetrating prime coat;
 - 2) where the National Weather Service official forecast of the high temperature for the immediate vicinity of the asphalt application for the 24-hour period following application is below 50°F (10°C).
- c. After January 1, 1982, no person shall cause or allow the use or application of cutback asphalt, or shall cause or allow the use or application of an emulsified asphalt containing petroleum solvents (diluent) in excess of 3 percent by volume for highway or street paving or maintenance, nor sell, or offer for sale such asphalts for such use or application. These provisions do not apply to cutback asphalt sold in a district for shipment and use outside that district.
- d. After January 1, 1982, road oils used for highway or street paving or maintenance applications shall contain no more than 0.5 percent of organic compounds which boil at less than 500°F as determined by ASTM D 402-73."

Currently, RACT eliminates the use of RC cutback asphalts, limits the use of MC cutback asphalts to prime coat applications and paving performed at temperatures less than 50 F (10 C), and exempts the use of all SC cutback asphalts (that is, road oils). By 1982, the use of MC cutback asphalts is to be eliminated, and maximum solvent content restrictions are to be placed on SC cutback asphalts and emulsified asphalts.

Since RACT has been implemented in each of the three APCDs under their local rules and regulations for air pollution control, it was possible to evaluate pre- and post-RACT use patterns of cutback and emulsified asphalts in California.

The California Department of Transportation (CalTrans), two paving contractors, and two emulsified asphalt suppliers were contacted for pre- and post-RACT use data necessary to complete California's state bituminous-materials-use table. In addition, county and CalTrans District highway departments from the Bay Area AQMD, the Fresno County APCD, and the South Coast AQMD were also contacted for information. All responses are summarized in Appendix A (Section 4.1.1.2). A list of California road construction and maintenance operations and a list of cutback and emulsified asphalt suppliers who serve California are also given in Appendix A (Sections 4.1.1.3 and 4.1.1.4, respectively).

2.3.1.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in California. The diversity in California's climate and topography for the mountain, valley, desert, and coastal regions has affected the extent to which emulsified asphalts have been successfully used in road construction and maintenance operations prior to RACT. The use of emulsified asphalts in California

dates back to the 1930's, although the research and development work was limited mainly to one supplier. As a result, California lagged behind other western states in developing and accepting the use of emulsified asphalts. Through the 1930's, emulsified asphalts were used in seal coat (or chip seal) work.

This work was sometimes unsuccessful due to inadequate product quality or training in the use of emulsified asphalts in adverse climates and topography. Extremes in temperature and humidity as well as high rainfall frequency have been blamed for much of the bad experience in the pre-RACT use of emulsified asphalts. The steep grades and tight working space on some mountain roads have made it economically impractical to haul hot-mixed products and maneuver large paving machines. Under these climatic and topographic adversities, the use of cutback asphalts has prevailed.

By the mid-1940's the use of emulsified asphalts was extended to curing seals and tack coat applications and it was at this time that CalTrans specified emulsified asphalts for optional use in road construction and maintenance operations which had normally been reserved for cutback asphalts. The use of emulsified asphalts in chip seal work continued to increase through the 1950's and early 1960's (as did the number of emulsified asphalt suppliers) with further use resulting from the marketing of emulsified asphalt slurry seal technology in the late-1960's.

The sales of cutback and emulsified asphalts from 1969 through 1978 are shown in Figure 2. The sales of SC cutback asphalts are also shown to illustrate their relative proportion of all cutback asphalt sales during this ten-year period.

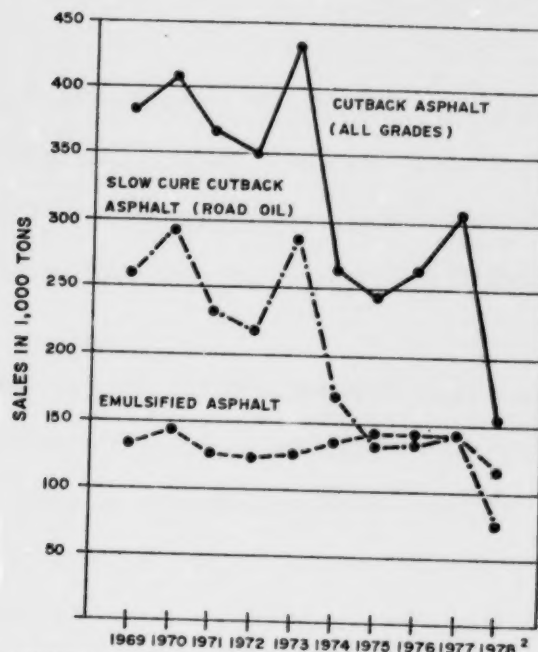


FIGURE 2. Cutback and emulsified asphalt sales in California ¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

There was a sharp drop in the sales of cutback asphalts from the 1973 to 1974 paving season, as a consequence of the Arab oil embargo, whereas the sales of emulsified asphalts over the same period increased about 12 percent. In 1978 the sales of all asphalts were down.

With the onset of asphalt emulsion workshops presented by the Asphalt Institute, the Federal Highway Administration (FHWA) and the Asphalt Emulsion Manufacturers Association (AEMA) to various state and county maintenance districts in California over the past couple of years, the use of emulsified asphalts has been on the rise. However, the use of cutback asphalts never rebounded from its low level in 1978. As an example, the use of RC cutback asphalts was discontinued in the 1978 paving season.

2.3.1.3 Post-RACT Use Patterns of Cutback and Emulsified Asphalts in California. The continued use of cutback asphalts in areas of adverse climate and topography, may present difficulty in fully implementing RACT in some areas of California. These areas include: the mountain regions with low temperatures and steep, narrow roads; the desert regions with high temperatures and low humidity; and parts of the coast with high rainfall and humidity and low temperatures. In addition, several respondents contended that the prohibition of cutback asphalts at temperatures in the low 50's F (10 C) may pose a problem, and it is expected that the problem will be compounded in several years when most APCDs will prohibit the use of cutback asphalts in cold weather. Many APCDs will also delete the prime coat exemption at the same time, so unless the use of emulsified asphalts can be developed further for use in prime coats and cold weather, departures from California APCDs' regulations may occur. The road construction and maintenance operations in question include asphalt concrete, road-mix asphalt surfacing, and patch material.

Table 4 presents a summary of post-RACT use of cutback and emulsified asphalts in the currently nonexempt operations. Values representing the continued use of cutback asphalts (that is, those which may require additional enforcement) are circled. No attempt was made to evaluate use levels after the 1980 paving season.

The CalTrans response in the first column of Table 4 shows existing use levels of cutback and emulsified asphalts from a statewide perspective. The CalTrans representative cited the use of cutback asphalts only in stock-pile mixes.

Contractors A and B, representing central and Southern California respectively, were fairly consistent in their responses, although Contractor

Table 4

POST-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS IN CALIFORNIA IN THE NONEXEMPT OPERATIONS^{a,b}

Road Construction or Maintenance Operation	Post-RACT Use for the 1980 Paving Season									
	CalTrans	Contr.		Supp.		Bay Area AQMD		Fresno County		South Coast AQMD
		A	B	A	B	CalTrans	Dist. #4	County	CalTrans	Dist. #8
								County		County
Asphalt Concrete										
Cutback	5	5	5	5	5	5	5	5	①	②
Emulsified	4	5	5	5	5	5	5	5	5	5
Road-Mixed Asphalt Surfacing										
Cutback	5	5	-	②	①	-	-	5	-	①
Emulsified	5	5	-	3	5	-	-	5	-	5
Seal Coat ^c										
Cutback	5	5	5	③	5	5	5	5	5	5
Emulsified	1	1	5	1	1	2	1	1	1	1
Fog Seal										
Cutback	5	5	③	③	5	5	5	5	5	5
Emulsified	1	1	1	1	1	5	5	1	1	1
Tack Coat										
Cutback	5	5	5	5	5	5	5	5	5	5
Emulsified	1	1	1	2	1	1	1	③	1	1
Patch Material:										
Immediate Use										
Cutback	5	5	5	5	②	5	5	②	①	①
Emulsified	5	5	5	5	5	5	5	5	5	5
Stockpile										
Cutback	①	5	5	5	②	①	②	②	①	①
Emulsified	5	5	5	5	5	5	5	5	5	5
Paved Shoulders										
Cutback	5	5	-	d	5	5	5	5	①	②
Emulsified	5	5	-		5	2	5	5	5	5

Table 4

(Continued)

Road Construction or Maintenance Operation	Post-RACT Use for the 1980 Paving Season									
	CalTrans	Concr.		Supp.		Bay Area AQMD		Fresno County APCD		South Coast AQMD
		A	B	A	B	CalTrans Dist. #4	County	Cal Trans. Dist. #6	County	CalTrans Dist. #8
Dust Palliative										
Cutback	5	5	-	5	5	5	5	②	5	5
Emulsified	3	5	-	5	2	1	5	2	5	5
Recycling										
Cutback	5	5	-	5	5	-	-	②	5	-
Emulsified	1	5	-	5	5	-	-	①	5	-

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

bExemptions may vary in other Air Pollution Control Districts.

cSeal coat includes rock and ship seal work.

dpaved shoulder work is included under fog seal.

B did note the use of cutback asphalts in fog seal applications.

Basically, Supplier A markets in central California whereas Supplier B markets in northern California. Both indicated that cutback asphalts are being used in road-mix asphalt surfacing. Supplier A also stated that cutback asphalts are used on a selected basis for seal coat and fog seal work, and Supplier B noted that cutback asphalts are sometimes used in patch material.

The Bay Area AQMD appears to have eliminated the use of cutback asphalts at the state and county level in all operations except stockpile mixes; however, the use of emulsified asphalts is restricted to seal coat and dust palliative work, and tack coat applications.

The Fresno County APCD and the South Coast AQMD show a greater use of emulsified asphalts but also a greater use of cutback asphalts. Cutback asphalts are generally-to-sometimes used in both districts in the following road construction and maintenance operations: asphalt concrete work, road-mixed asphalt surfacing, and immediate-use and stockpile patch material.

2.3.2 COLORADO

2.3.2.1 RACT Status in Colorado. RACT for the use of cutback asphalts in road construction and maintenance operations has not been federally approved (as of July 18, 1980). RACT was proposed by the Colorado Air Quality Control Commission, which adopted the regulation on June 30, 1980. The regulation is to be implemented in Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson Counties -- all of which are in ozone nonattainment areas. The regulation, which is found in Regulation 7, of Colorado's revised SIP (Section XI, Use of Cutback Asphalt), is written as follows:

"XI Use of Cutback Asphalt

A. Definitions:

1. Asphalt: The dark-brown to black cementitious material (solid, semi-solid, or liquid in consistency) of which the main constituents are bitumens which occur naturally or as a residue of petroleum refining.
2. Emulsified asphalt: Asphalt emulsions produced by combining asphalt and water with emulsifying agent.
3. Cutback Asphalt: Any asphalt which has been liquefied or made more plastic by blending with a VOC as a solvent or, in the case of some slow cure asphalts, which has been produced directly from the distillation of petroleum and contains condensate therefrom.

Emulsified asphalt which contains less than five percent of VOC by weight of residual asphalt is not included in this definition. (Residual oils are not included in the meaning of the term "VOC").

4. Penetrating Prime Coat: An application of low-viscosity liquid asphalt to an absorbent surface in order to prepare it for paving with an asphalt concrete.

B. Limitations:

1. Applicability: Provisions of this Section apply to the use or storage of cutback asphalt for the paving and maintenance of all

public roadways including alleys only within ozone nonattainment areas.

2. Storage: Stockpiles of aggregate mixed with cutback asphalt are permitted during the contiguous months of October through April. After December 31, 1981, such storage is not permitted during May through September except where it can be demonstrated to the Division that such storage is necessary.
3. Use: Cutback asphalt may be used for any paving purposes during the contiguous months of October through April. After December 31, 1981, no person shall use cutback asphalt for any purpose during the contiguous months of May through September except as provided below.
 - a. If used solely as a penetrating prime coat;
 - b. If the user can demonstrate to the Division that under the conditions of its intended use there will be no emissions of organic compounds to the ambient air.
4. Phase-Out Option:
 - a. The prohibition against the use of cutback asphalt designated in paragraph 3 above may be postponed until December 31, 1982 if the applicant of such postponement submits to the Division no later than December 31, 1980 a written schedule which:
 - i. Shows how the use of emulsified asphalt by the applicant will be phased in between the effective dates of this regulation and October 1, 1982 to replace cutback asphalt for all paving purposes except penetrating prime coat; and
 - ii. Demonstrate that not less than thirty percent of the total liquid asphalt gallonage used for seal coating (e.g. chip sealing) during the phased-in period will be emulsified; and
 - iii. Employs emulsified asphalt for seal coating at least two of the following three years 1980, 1981, and 1982.
 - b. Said schedule must receive written approval from the Division. Such approval shall be granted if the requirements of subparagraph 4(a) are met.
 - c. The applicant must complete the projects designated in such schedule except that a project not listed on that approved schedule may qualify in lieu of an approved project if the substitution is approved by the Division in writing.

C. Record Keeping:

1. During the months of May through September those responsible for the use or storage of any cutback asphalt as permitted in subparagraph 3(a) and (b) and paragraph 2 shall keep records of same schedule, type and amount of solvents used."

Actually there are two RACT compliance options available to one who uses cutback asphalts. Both options require the user to limit the use of cutback asphalts in stockpile mixes by December 31, 1981. If the user does not make any effort to use emulsified asphalts by December 31, 1981, he must limit (by December 31, 1981) the use of cutback asphalts to those prime coat applications and those road construction or maintenance operations where it can be demonstrated by the user that no VOCs are emitted. If the user does undertake measures to use emulsified asphalts by 1981 he can extend the December 31, 1981 compliance date by one year. The user must then submit a schedule describing how emulsified asphalts are to be phased-in, demonstrate that at least thirty percent of his total liquid asphalts used for seal coating through 1982 are to be emulsified asphalts, and use emulsified asphalts in at least two of the three paving seasons (starting in 1980).

Most users of cutback asphalts have selected the phase-in approach for switching to emulsified asphalts. Therefore, it is practical to present a discussion of only pre-RACT cutback and emulsified asphalt use patterns in Colorado. The Colorado Department of Highways (CDH), the Asphalt Institute, one city department of public works, three county road and bridge departments, two contractors, and one emulsified asphalt supplier provided information on the pre-RACT use patterns of cutback and emulsified asphalts. A list of Colorado road construction and maintenance operations and cutback and emulsified asphalt suppliers who serve Colorado are given in Appendix A (Section 4.1.2.1 and 4.1.2.2, respectively).

2.3.2.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Colorado. Emulsified asphalts were used in Colorado in the early 1950's, although

numerous seal coat (that is, chip seal) projects in which cutback asphalts were substituted with emulsified asphalts resulted in failure. This, in part, was due to the time delay between spraying the emulsified asphalts from the distributor truck onto the road surface and covering the sprayed film with a layer of aggregate chips. Such timing was, and still is, critical in the Colorado nonattainment areas because of low humidity, which causes the emulsified asphalt to break and the water to evaporate quickly. Also, some parts of Colorado in the higher elevations are subject to a high frequency of daily showers which can cut the work day in half when chip sealing with emulsified asphalts.

Around 1952, CDH used an SS emulsified asphalt to stabilize eastern Colorado sand subbase material. This was a new use of any asphalt material in Colorado and could not be considered a substitute for cutback asphalts. In the early 1960's, SS-1 and SS-1h emulsified asphalts were used in various types of base stabilization and chip seal work, and tack coat and fog seal applications; however, some problems involving premature breaking were experienced. These were somewhat alleviated by spraying water onto the aggregate or road surface to lengthen the set time.

The use of CRS in 1965 proved to be more effective than the earlier anionic emulsified asphalts. At that time, chip seal work was done primarily by the counties because CDH was relying more on hot plant mix surface courses for thin surface overlays. The relationship between sales of cutback and emulsified asphalts from 1969 through 1978 is shown in Figure 3.

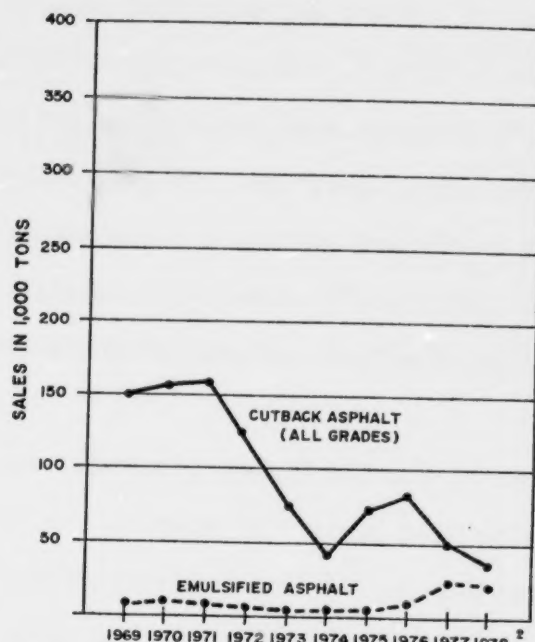


FIGURE 3. Cutback and emulsified asphalt sales in Colorado ¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

In 1969, sales of cutback asphalts were approximately 15 times greater than those of emulsified asphalts. The sales of cutback asphalts declined through 1974, whereas those of emulsified asphalts remained relatively constant. By 1978, the sales of emulsified asphalts were nearly half those of cutback asphalts.

Asphalt emulsion workshops have been conducted in Colorado (such as the one held in Colorado Springs in 1979), but the use of cutback asphalts continues to be prevalent in some chip seal work and other surface applications. However, most users, as noted above, are selecting the phase-in option under RACT and are beginning to increase their overall use of emulsified asphalts, especially in chip seal work.

The pre-RACT use of cutback and emulsified asphalts for the 1980 paving season is shown in Table 5. Values representing continued use of cutback asphalts in the nonexempt road construction and maintenance operations have been circled. The exempt operations have been underscored. The seal coat category is also underscored because all respondents had opted for the phase-in option which conditionally exempts this category. No attempt was made to evaluate the use of cutback and emulsified asphalts after the 1980 paving season.

The representative from the Asphalt Institute responded on the basis of all Colorado nonattainment areas. He noted that cutback asphalts are generally-to-sometimes used in all road construction and maintenance operations except plant mix bituminous base courses and paved shoulder and dust palliative work. CDH, responding from a Denver perspective, indicated that cutback asphalts are used in only four categories. Both respondents agreed that the general uses of emulsified asphalts are in tack coat applications and fog seal and dust palliative work.

The one department of public works that was contacted does about ninety percent of the road construction and maintenance operations in its jurisdiction. The engineer representing the department mentioned that forty city blocks (each about five hundred to six hundred feet long) can be chip sealed with RC-800, and he estimated that about twenty-five blocks could be chip sealed with an emulsified asphalt. He contended that the rapid set time of emulsified asphalts, which becomes shorter in low relative humidity (as low as ten percent in his area) and high temperatures, would essentially double the number of passes made by the distributor truck. When he uses cutback asphalts, the distributor bar extends the full length of the street

Table 5

PRE-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS IN COLORADO^a

Road Construction, or Maintenance Operation	Pre-RACT Use for the 1980 Paving Season										Supplier ⁹
	AI	CDH		Dept. of Pub. Works	County Road & Bridge Dept.			Contractor			
		Denver County	County		A	B	C	A	B		
Plant Mix Bituminous Base Course											
Cutback	5	5		5	5	5	5	5	5	5	- 3
Emulsified	3	5		5	5	5	5	5	5	5	
Seal Coat											
Cutback	1	2		1		1	5	-	d		1 3
Emulsified	2	2		2	c	5	1	-			
Fog Seal											
Cutback	②	5		5	5	5	5	5	5	5	5
Emulsified	1	1		5	5	5	5	2	1	5	5
Prime Coat											
Cutback	1	1		3	5	5	1	1 ^e	5	5	1 5
Emulsified	2	5		5	5	1	2	5	1	5	
Tack Coat											
Cutback	②	5		5	5	5	5	5	5	5	- 1
Emulsified	1	1		1	1	1	1	1	1	1	
Patch Material											
Immediate Use											
Cutback	①	①		5	②	5	5	5	5	5	- 5
Emulsified	5	5		5	5	5	5	5	5	5	
Stockpile											
Cutback	1	1		1	5	1	5	1	1	5	- 5
Emulsified	5	5		5	1	5	5	5	3	5	
Paved Shoulders											
Cutback	5	5		5	5	5	5	b	5 ^b	5	- 5
Emulsified	5	5		5	5	5	5	1	1 ^{b,f}	5	
Dust Palliative											
Cutback	5	5		5	5	5	5	5	5	5	5
Emulsified	1	1		5	5	5	5	1	1	5	1 1
Aggregate Precoat											
Cutback	5	5		5	5	5	5	5	5	5	5
Emulsified	5	5		5	5	5	5	5	5	5	5

(Continued)

where 1 = generally used
2 = sometimes used
3 = used on a selected basis
4 = currently not used
5 = never used

beveled shoulders is an extension of a base or surface course.

This operation was dropped due to reallocation of budgeted funds.

This operation is just picking up after two to three year slow period. The contractor intends to use RC-800DN (a rubberized cutback asphalt) although he prefers RC-800.

^eThis contractor primes with an MC-70 around curb and man-hole areas.

^fThe contractor referred to this as a fog seal-type application.

The supplier did not feel he could provide realistic cutback asphalt use values for all operations.

(that is, both lanes). The chips can then be spread down one side of the street in the morning and on the other side in the early afternoon. However, emulsified asphalts cannot be sprayed unless aggregate chips are immediately available for spreading. Therefore, if he were to use emulsified asphalts the distributor bar would have to be shortened to cover only a single lane at a time (that is, the maximum width of the chip spreader) to cover all of the emulsified asphalt. Nonetheless, the department is increasing its use of emulsified asphalts during the 1980 paving season as part of a phase-in schedule.

The use of cutback asphalts by three county road and bridge departments is limited to the exempt road construction and maintenance operations. One county engineer stated that the use of emulsified asphalts is not practical at elevations above six thousand feet; the cool temperatures and high frequency of rainfall shorten the working day. In these isolated areas, the use of cutback asphalts will most likely continue until 1983.

The contractors and suppliers also noted that the use of cutback asphalts was limited to the exempt road construction and maintenance operations. One contractor stated that the best substitute for RC cutback asphalts in chip seal work is RS-K emulsified asphalts -- rubberized emulsified asphalts which are becoming more widely used in Colorado, and according to the supplier, in other midwestern states.

2.3.3 INDIANA

2.3.3.1 RACT Status in Indiana. As of June, 1980, RACT for the use of cutback asphalts in Indiana road construction and maintenance operations has not received EPA approval; it was proposed by the Indiana Air Pollution Control Board, signed into law in December, 1979, and implemented throughout the state in January, 1980¹. The regulation has been submitted in Indiana's revised SIP (Articles 1 and 8 of 325 Indiana Administrative Code).²

Cutback asphalt is defined in Section 1(a)(22) of Article 1 of Indiana's revised SIP as, "Asphalt cement liquified by blending with volatile organic compounds, and which is used for the purpose of paving and/or repairing a road surface." The asphalt paving regulation is found in Section 2 of Rule 5, Article 8 and lists the following conditions:

- "(a) This Section applies to any paving application anywhere in the State. For the purposes of this section, the term "asphalt emulsion" shall mean any dispersion of asphalt cement in water, optional additives, optional distillates, and emulsifying agents.
- (b) No person shall cause or allow the use of cutback asphalt or asphalt emulsion containing more than seven percent (7%) oil distillate by volume of emulsion as determined by ASTM D-244 for any paving application except as used for the following purposes:
 - (1) Penetrating prime coat
 - (2) Stockpile storage
 - (3) Application during the months of November, December, January, February, and March."

¹RACT implementation dates are found in Section 1 of Rule 5, Article 8.

²Articles 1 and 8 of 325 Indiana Administrative Code were formerly APC 1 and 15, respectively.

Although RACT for the use of cutback asphalts has not been federally approved for Indiana, the provisions of the regulation were implemented on January 20, 1980 throughout the state under 325 Indiana Administrative Code. Thus, it is possible to evaluate pre- and early post-RACT use patterns of cutback and emulsified asphalts in the state.

The Indiana State Highway Commission (ISHC), several urban and rural county highway departments, and two Indiana contractors (one of which supplies other users with cutback and emulsified asphalts) were asked to complete the bituminous-materials-use table developed for Indiana. Their responses are summarized in a composite bituminous-materials-use table in Appendix A (Section 4.1.3.1) A list of Indiana road construction and maintenance operations, with the grades of cutback and emulsified asphalts that ISHC specifies, and a list of cutback and emulsified asphalt suppliers who serve Indiana, with the products those suppliers offer, are also given in Appendix A (Section 4.1.3.2 and 4.1.3.3, respectively).

2.3.3.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Indiana. Indiana has used cutback and emulsified asphalts interchangeably in a variety of road construction and maintenance operations prior to RACT implementation (see Appendix A, Section 4.1.3.1). The idea of substituting emulsified asphalts for cutback asphalts in Indiana road construction and maintenance operations was put forth in the late 1920's or early 1930's by John F. Kelly and K. E. McConnaughay.³ They introduced a new multi-

³The reference material, "PRE COTE, Bitumen and Aggregate: An Improved Type of Pavement," does not have a copyright date; however, a reference was made on page 28 of the pamphlet to 1928 revisions of Bulletin 1216, published by the U.S. Department of Agriculture, Bureau of Public Works.

use paving product called PRE COTE which was a cold-laid mix prepared with emulsified asphalts. PRE COTE chemists concluded that the emulsified bitumens were often more advantageous than cutback asphalts and even the hot-mixed bitumen products. In subsequent years, McConnaughay formed his own company, K.E. McConnaughay, Inc., specializing in emulsified asphalt plants and processes.

In 1934, ISHC specified emulsified asphalts as bituminous materials for use in bituminous coated aggregate surface courses. Since then ISHC has been able to practically eliminate the use of cutback asphalts in their six highway districts. Figure 4 shows the relationship between the sales of cutback and emulsified asphalts in Indiana from 1969 through 1978.

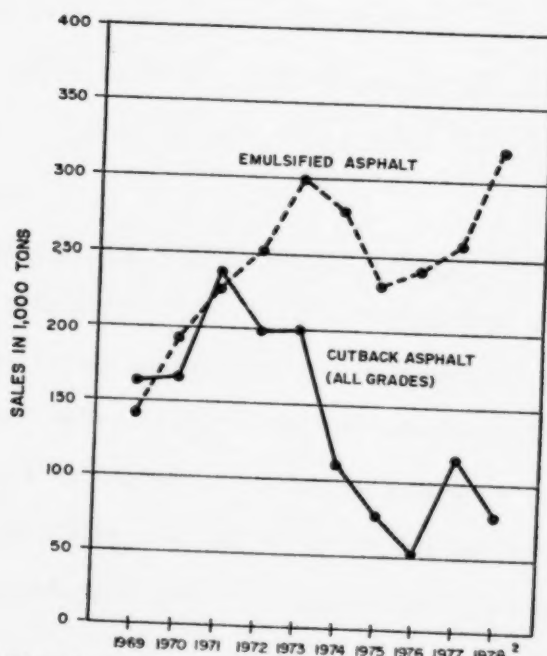


FIGURE 4. Cutback and emulsified asphalt sales in Indiana¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

Since 1972 the sales of emulsified asphalts have surpassed those of cutback asphalts, with sales of emulsified asphalts approximately four times greater than those of cutback asphalts in 1978. However, 1978 estimates also show that 80,000 tons of cutback asphalt were sold in that year, primarily for use by the counties -- specifically those in northern Indiana which are in nonattainment with respect to ozone.

Asphalt emulsion workshops, conducted by the Asphalt Institute in each of Indiana's six highway districts, were held in the spring of 1980 to familiarize county pavers with the use of emulsified asphalts. The workshops were half-day sessions geared at county chip seal work -- a paving operation which can account for eighty percent of a county's highway budget in Indiana.

2.3.3.3 Post-RACT Use Patterns of Cutback and Emulsified Asphalts in Indiana. Extensive pre-RACT use of emulsified asphalts and good coordination between ISHC and the users and suppliers of emulsified asphalts have prepared the state and most of the county highway departments in Indiana for RACT implementation; however, there are some counties which continue to use cutback asphalts and may thus present some isolated enforcement problems. The projected use of cutback and emulsified asphalts in Indiana from April 1 through October 31, 1980 in the nonexempt road construction and maintenance operations is shown in Table 6. Values representing continued use of cutback asphalts (that is, those which may require enforcement) are circled. No attempt was made to predict use levels after the 1980 paving season.

RACT implementation at the state level has been essentially achieved because of extended pre-RACT use of emulsified asphalts. Prior to January 1980, ISHC had been using some cutback asphalts in road mix bituminous base courses, road mix bituminous pavements, bituminous seal coats, and tack coats

Table 6

POST-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS
IN INDIANA IN THE NONEXEMPT OPERATIONS^a

Road Construction or Maintenance Operation	Post-RACT Use (as of January 20, 1980) from April 1 to October 31, 1980		
	ISHC ^b	Contractor	
		A	B
Plant Mix Bituminous Base Course			
Cutback	-	5	5
Emulsified	-	2	1
Road Mix Bituminous Base Course			
Cutback	-	①	5
Emulsified	-	2	1
Bituminous Stabilized Subbase			
Type I			
Cutback	-	5	5
Emulsified	-	1	1
Type II			
Cutback	-	5	5
Emulsified	-	1	5
Bituminous Coated Aggregate Pavement			
Cutback	-	5	5
Emulsified	-	1	1
Road Mix Bituminous Pavement			
Cutback	-	①	5
Emulsified	-	2	1
Cold Mix Bituminous Pavement ^c			
Immediate Use			
Cutback	-	5	②
Emulsified	-	1	1
Bituminous Seal Coat			
Cutback	-	5	5
Emulsified	-	1	1
Fog Seal			
Cutback	-	5	5
Emulsified	-	1	1
Bituminous Tack Coat			
Cutback	-	5	5
Emulsified	-	1	1
Bituminous Shoulders			
Cutback	-	5	5
Emulsified	-	2	1
Recycling			
Cutback	-	5	5
Emulsified	-	5	1

Table 6
(Continued)

Road Construction or Maintenance Operation	Post-RACT Use (as of January 20, 1980) from April 1 to October 31, 1980		
	ISHC ^b	Contractor	
		A	B
Dust Palliative			
Cutback	-	①	①
Emulsified	-	5	4
Aggregate Precoat			
Cutback	-	5	②
Emulsified	-	1	2

^aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

^bThe ISHC commented, "We have not filled in the sections of the questionnaire dealing with expected use. We are now using a very minimal amount of cutback asphalt."

^cCold mix bituminous pavement mixes are used as bituminous patch material.

(see Appendix A, Section 4.1.3.1). For the 1980 construction year, ISHC contends that only minimal amounts of cutback asphalts are to be used.

Several urban and rural Indiana counties, two of which have been designated as ozone nonattainment areas, were contacted for information pertaining to the use of cutback and emulsified asphalts in their highway work. Their evaluations of the bituminous-materials-use table prepared for Indiana were incomplete because many of the road construction and maintenance operations are not performed in their respective counties. However, it can be generally surmised from discussions with the respective county highway engineers that if the option of choosing between cutback and emulsified asphalts exists, cutback asphalts will most likely be selected. The primary reason for this selection is that the county pavers are only familiar with cutback asphalts and have had limited success with emulsified asphalts. Based on discussions with ISHC and McConnaughay, Inc. the counties which may require more enforcement effort are in northern Indiana. In some counties in this area, road construction and maintenance operations which use cutback asphalts include the road mix bituminous base courses and bituminous seal coats (that is, chip seal work).

Both contractors responded based on their own work experience; however, Contractor B is also a bituminous material supplier and is familiar with other road construction and maintenance operations not directly associated with his company. Contractor A explained that he uses cutback asphalts as a prime coat application in the road mix bituminous base course and road mix bituminous pavement categories. Contractor B indicated that cutback asphalts are sometimes used in cold mix bituminous pavements for immediate use. Contractors A and B agreed that cutback asphalts are generally used in dust palliative work; contractor B also indicated that cutback asphalts are used in aggregate precoat work.

2.3.4 MISSOURI

2.3.4.1 RACT Status in Missouri. Missouri's RACT for the use of cutback asphalts in road construction and maintenance operations was approved by EPA on April 9, 1980 on the basis that EPA's equivalency criterion was met.⁴ The Missouri Department of Natural Resources proposed RACT on November 14, 1978, and it was adopted July 12, 1979. RACT was submitted as part of Missouri's revised SIP (Sections 10 CSR 10-2.220, -5.310, and -6.020, Division 10, Title 10, Rules of the Department of Natural Resources) and applies only to the Kansas City and St. Louis metropolitan areas -- the only ozone nonattainment areas in Missouri.

In addition to Missouri's Air Pollution Control Program, there are four approved local agencies in the areas to be regulated which have similar programs; they are the Kansas City Air Quality Section, City of Independence Public Works Department, St. Louis City Division of Air Pollution Control, and St. Louis County Division of Environmental Health Services. Representatives of each agency have indicated that cutback asphalt regulations should be adopted by the end of 1980 and will be at least as stringent as those at the state level.

Cutback and emulsified asphalts are defined in Section 10 CSR 10-6.020.

Cutback asphalt is defined as, "Asphalt cement which has been liquefied by blending with petroleum solvents (diluent)s."

Emulsified asphalt is defined as, "An emulsion of asphalt and water that contains a small amount of an emulsifying agent, as specified in ASTM D 977-77 or ASTM D 2397-73."

⁴EPA's equivalency criterion is explained in Section 2.1.

RACT for the Kansas City area is found in 10 CSR 10-2.220 and reads as follows:

"PURPOSE: This regulation restricts volatile organic compounds emissions from cutback asphalt paving operations.

(1) Application

- (A) This regulation shall apply only in Clay, Jackson, and Platte Counties.
- (B) This rule limits the use or application of liquefied cutback asphalt in paving and maintenance operations on highways, roads, parking lots, and driveways.

(2) General

- (A) After December 31, 1982 no person may cause or permit the use or application of liquefied cutback asphalts on highways, roads, parking lots, and driveways during the months of May, June, July, August, and September except as permitted in Section (3). This subsection refers to liquefied cutback asphalt which is directly applied or used in a plant-mix or road-mix.

(3) Exceptions

- (A) The use or application of liquefied cutback asphalts is permitted if:
 - 1. The liquefied cutback asphalt is used in a plant-mix or road-mix which is used solely for filling potholes or for emergency repairs; or
 - 2. The liquefied cutback asphalt is used to produce a plant-mix manufactured for resale or for use outside Clay, Jackson, and Platte Counties; or
 - 3. The liquefied cutback asphalt is to be used solely as an asphalt prime coat or an asphalt seal coat on absorbent surfaces."

RACT for the St. Louis area (City of St. Louis and St. Louis, St. Charles, Jefferson, and Franklin Counties) is found in 10 CSR 10-5.310. Sections (1)(B), (2)(A), and (3)(A)1 and 3 of 10 CSR 10-2.220 are included verbatim in 10 CSR 10-5.310. Since RACT is not to be implemented until

January 1, 1983 it was possible to evaluate only pre-RACT use patterns of cutback and emulsified asphalts in Missouri.

The Missouri Highway and Transportation Department (MHTD), the Asphalt Institute, two urban county highway departments, two paving contractors, and two emulsified asphalt suppliers provided information on the historical and current uses of cutback and emulsified asphalts in the two metropolitan areas. A list of road construction and maintenance operations in Missouri with the grades of cutback and emulsified asphalts specified for each by MHTD and a list of cutback and emulsified asphalt suppliers who serve Missouri are presented in Appendix A (Sections 4.1.4.1 and 4.1.4.2, respectively).

2.3.4.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Missouri. Historically, there have been significantly more cutback asphalts than emulsified asphalts used in Missouri road construction and maintenance operations. If pre-RACT use levels continue into the 1983 paving season, Missouri may have difficulty in fully implementing RACT in some areas of the state for most nonexempt operations; however, the respondents stated that the use of cutback asphalts should decline in a few years as a result of market conditions and more experience in the use of emulsified asphalts.

The sales of cutback and emulsified asphalts in Missouri from 1969 through 1978 are shown in Figure 5. Although the graph indicates a greater use of cutback asphalts than emulsified asphalts statewide, the ratio of cutback asphalts to total liquid asphalts used in the Kansas City and St. Louis metropolitan areas is less than the ratio in attainment areas.

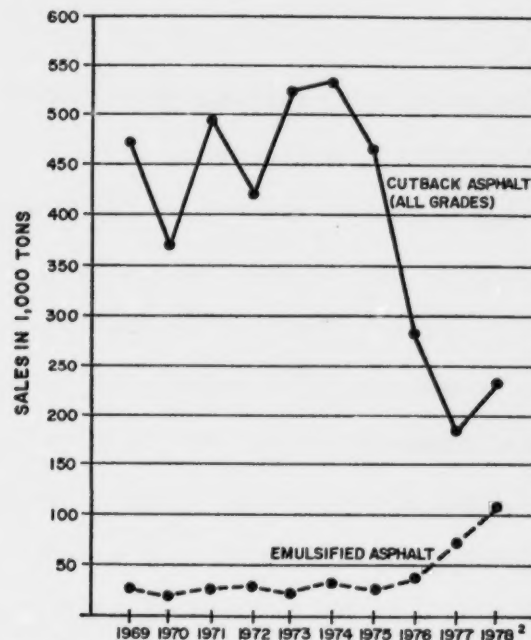


FIGURE 5. Cutback and emulsified asphalt sales in Missouri¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

MHDT Districts 4 and 6, two of Missouri's ten highway districts, have jurisdiction over the state road construction and maintenance operations in the Kansas City and St. Louis areas, respectively. In the early 1970's these two districts made some of MHTD's first attempts to use emulsified asphalts in road construction and maintenance operations. The experimental projects consisted of using emulsified asphalts in seal coat and blade-mixed surface leveling courses. The first emulsified asphalts used were unable to bind the aggregate properly; however, this problem was eventually overcome by switching to different grades of emulsified asphalts.

It was not until the mid 1970's that emulsified asphalts were specified and widely used by MHTD. At that time the sales of cutback asphalts were 47 times greater than sales of emulsified asphalts (see Figure 5). Many

of the persons contacted in this study felt that the reluctance to accept emulsified asphalts at this time as a substitute for cutback asphalts stemmed from unsubstantiated claims by emulsified asphalt suppliers, past road failures with emulsified asphalts, and higher emulsified asphalt prices. However, advances in the emulsified asphalt industry in terms of product development and marketing, coupled with price increases for cutback asphalts resulting from the Arab oil embargo, led to an increase in the use of emulsified asphalts in Missouri. By 1978 the sales ratio had decreased from 47:1 to 2:1, with the use of emulsified asphalts accounting for nearly thirty percent of MHTD's liquid asphalts. This change came in maintenance, whereas the use of emulsified asphalts in new construction remained unchanged. As indicated by one emulsified asphalt supplier, the increase in solvent availability for 1980 has made the prices of cutback asphalts more competitive with those of emulsified asphalts in Missouri.

In the past few years, various emulsified asphalt workshops have been presented throughout the state by MHTD's Maintenance and Traffic Division, the Asphalt Institute, the American Public Works Association, the National Asphalt Paving Association (NAPA), and the University of Missouri. However, the use of cutback asphalts remains widespread among the users contacted in this study in all road construction and maintenance operations which RACT will not exempt.

The projected use of cutback and emulsified asphalts from May 1 through September 30, 1980 in Missouri road construction and maintenance operations is shown in Table 7. In the nonexempt road construction and maintenance operations, low cutback values, which represent continued use of cutback asphalts, are circled to highlight the operations which may eventually require enforcement. The exempt road construction and maintenance operations

Table 7

PRE-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS IN MISSOURIA

Pre-RACT Use from May 1 to September 30, 1980													
Kansas City Area													
St. Louis Area													
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Table 7

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use from May 1 to September 30, 1980									
	Kansas City Area					St. Louis Area				
	MHTD District 4	AI	County A	Contractor A	Supplier A	MHTD District 6	County B	Contractor B	Supplier B	
Aggregate Precoat										
Cutback	5		5	5	5	②	5	5	5	
Emulsified	5		5	5	5	1	5	5	5	
Recycling										
Cutback	②		①	③	5	5	5	5	②	
Emulsified	2		5	5	5	5	5	5	2	

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

bSeal coat applications are used as an immediate-use patch material.

cPaved shoulder work is an extension of a seal coat.

dRoad mix bituminous pavement mixes are used as immediate use patch material.

ePaved shoulder work is an extension of a road mix bituminous pavement.

fCutback asphalts are used in cold mix operations.

gPaved shoulder work is in extension of plant or road mix bituminous pavement.

are underscored. No attempt was made to predict use levels resulting from RACT, which is to be effective January 1, 1983. The following discussion is limited to the road construction and maintenance operations which Missouri's RACT proposes not to exempt.

The Asphalt Institute indicated that cutback asphalts are generally used in Missouri's road mix bituminous pavements and dust palliative work, and sometimes used in fog seal and tack coat applications and recycling operations.

MHTD District 4 noted that cutback asphalts are used only in tack coat applications, whereas use by MHTD District 6 appears to occur to a greater extent. Both MHTD Districts expect an overall reduction in the use of cutback asphalts by the end of the 1980 paving season.

The introduction of emulsified asphalts at the county level is comparatively recent, but their use is growing rapidly. One county in the Kansas City area has begun using emulsified asphalts to gain pre-RACT experience and expects to replace cutback asphalts with emulsified asphalts over the next two years wherever substitution will be required. The county representing the St. Louis area is already using emulsified asphalts to the fullest extent.

Different viewpoints were presented by the two contractors. The contractor in the St. Louis area indicated that most of his customers request cutback asphalts -- a fact which he attributed to a lack of available emulsified asphalts. This is shown by his use of cutback asphalts in plant- and road-mix bituminous pavements, tack coat applications, dust palliative work, and recycling operations. In contrast, the Kansas City contractor indicated that ninety percent of his asphalt use (including asphalt cements)

is emulsified asphalts and foresees an even greater amount when current MHTD contracts which specify cutback asphalts are completed.

Both suppliers noted the use of cutback asphalts in nearly all road construction and maintenance operations. Fog seal and aggregate precoat applications were the only categories in which the use of cutback asphalts was not indicated by the suppliers.

2.3.5 PENNSYLVANIA

2.3.5.1 RACT Status in Pennsylvania . On May 20, 1980, the EPA conditionally approved Pennsylvania's RACT for the use of cutback asphalts with the provision that Pennsylvania submit revisions (effective by 1982) which further restrict the use of cutback asphalts and place limitations on solvent content in emulsified asphalts. RACT was proposed by the Pennsylvania Bureau of Air Quality Control, adopted by the Commonwealth of Pennsylvania on April 9, 1979, and is applicable to all areas of Pennsylvania because the entire state has been designated as nonattainment with respect to ozone. RACT has been submitted in Pennsylvania's revised SIP (Sections 121.1 and 129.64 of "Title 25, Rules and Regulations, Part 1, Department of Environmental Resources, Subpart C, Protection of Natural Resources, Article III, Air Resources").

In Section 121.1 of the revised SIP cutback asphalt is defined as, "Asphalt cement which has been liquefied by blending with petroleum solvents (dilutents) which upon application evaporate to the atmosphere; excluded from this definition is any emulsified asphalt paving compound which contains less than 12% of solvent (diluent) by volume." The cutback asphalt paving regulation is found in Section 129.64 and reads as follows:

"After April 30, 1980, no person may cause, allow, or permit the mixing, storage, or application of cutback asphalt for paving operations except when:

- (a) Long-life stock-pile storage is necessary;
- (b) The use or application between October 31 and April 30 is necessary; or
- (c) The cutback asphalt is to be used solely as a penetrating prime coat, a dust palliative, a tack coat, a pre-coating of aggregate, or a protective coating for concrete."

Draft revisions to the existing regulation do not exempt the use of cutback asphalts as a tack coat and as a protective coating for concrete. In addition, the following limits on solvent content for specific emulsified asphalt grades may be proposed:

Emulsion Grade	AASHTO Equivalent	Emulsion Type	% Solvent	
			Min.	Max.
E-1	RS-1, CRS-1	Rapid setting	-	0
E-2	RS-2	Rapid setting (anionic)	-	0
E-3	CRS-2	Rapid setting (cationic)	0	3
E-4	MS-2	Medium setting	0	12
E-5	CMS-2	Medium setting	0	12
E-6	SS-1, CSS-1	Slow setting (soft residue)	-	0
E-8	SS-1h, CSS-1h	Slow setting (hard residue)	-	0
E-10		Medium setting (high float)	2	7
E-11		High float	0	7
E-12		Medium setting (cationic)	2	8

Because Pennsylvania's RACT implementation date was May 1, 1980, it was possible to evaluate early post-RACT use patterns of cutback and emulsified asphalts as well as pre-RACT use patterns in the state.

The Pennsylvania Department of Transportation (PennDOT), The Asphalt Institute, the Bureau of Municipal Services, three paving contractors, and two emulsified asphalt suppliers completed the bituminous-materials-use table developed for Pennsylvania. Their responses are tabulated in Appendix A (Section 4.1.5.1). The road construction and maintenance operations evaluated for Pennsylvania, with the grades of cutback and emulsified asphalts that PennDOT specifies for use in these operations, and a list of product suppliers which serve Pennsylvania are also given in Appendix A (Sections 4.1.5.2 and 4.1.5.3).

2.3.5.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Pennsylvania. The use of emulsified asphalt in Pennsylvania as a substitute for cutback asphalts was initiated by PennDOT shortly after the Arab oil embargo of 1973-74. The sales of cutback and emulsified asphalts from 1969 through 1978 are shown in Figure 6.

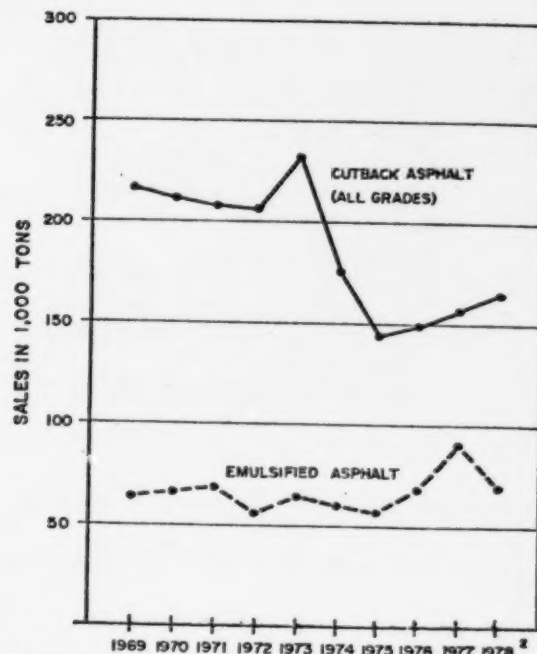


FIGURE 6. Cutback and emulsified asphalt sales in Pennsylvania ¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

PennDOT used cutback and emulsified asphalts in approximately a three-to-one ratio in 1973. In 1974 PennDOT issued a Department policy which set objectives to increase the use of emulsified asphalts and decrease that of cutback asphalts. By 1978 the ratio was reversed with emulsified asphalts being used three times more often than cutback asphalts in PennDOT work.

In 1975, under the direction of Pennsylvania's district office of the Asphalt Institute and the Pennsylvania Association of Asphalt and Tar Applicators (PAATA), the Municipal Training Division of the Department of Community Affairs and the Bureau of Municipal Services of PennDOT began a series of pre-RACT seminars dealing with emulsified asphalts. The goals of the seminars were to introduce emulsified asphalt products to Pennsylvania pavers and to encourage the use of these products wherever possible.

In 1977 the EPA and the Pennsylvania Department of Environmental Resources (PennDER) used EPA's emission offset policy to increase the use of emulsified asphalts at the state level⁵. A Volkswagen Rabbit plant was constructed in New Stanton, Pennsylvania. In order to offset an estimated 900 tons of VOC emissions per year from the plant, PennDOT decreased the use of cutback asphalts and increased the use of emulsified asphalts.⁶ The reduction in the use of cutback asphalts was expected to reduce VOC emissions generated from paving operations by approximately 1,000 tons. The areas involved include the southwestern air quality control region of Pennsylvania and seven contiguous counties.

Despite PennDOT's success in switching to emulsified asphalts, Figure 6 shows that large quantities of cutback asphalts were still being sold in Pennsylvania in the mid- to late-1970's. The reason for this is that substitution efforts had been mainly limited to PennDOT road construction and maintenance operations. However, 57 percent of Pennsylvania's 115,000 miles of road are under local jurisdiction.

⁵The emission offset policy requires an emission tradeoff on a better than one-to-one basis when a polluting industry moves into a nonattainment area. The policy objective is to reduce air pollution while still allowing economic growth.

⁶Specific control guidelines are given in Appendix A, Section 4.1.5.4.

Additional pre-RACT programs have been instituted to increase the local use of emulsified asphalts and prepare the users for any change in paving operations which RACT might require. In the past three years audio-visual training programs, designed specifically for the individuals who perform township paving, have been presented as one-day seminars in the 11 Pennsylvania Highway Districts. The material in these sessions has been presented enthusiastically and the local participation has been good. The presentations have been conducted and sponsored by PennDOT, the Asphalt Institute, PAATA, the Department of Community Affairs, paving contractors, and emulsified asphalt manufacturers and suppliers. Consequently, the local users had gradually become attuned to emulsified asphalt handling and application techniques prior to RACT's implementation date, May 1, 1980.

2.3.5.3 Post-RACT Use Patterns of Cutback and Emulsified Asphalts in Pennsylvania. RACT implementation should be achieved relatively easily due to Pennsylvania's overall pre-RACT preparation for the switch to emulsified asphalts. The projected use of cutback and emulsified asphalt in Pennsylvania from May 1 through October 31, 1980 in the currently nonexempt road construction and maintenance operations is shown in Table 8. Values representing continued use of cutback asphalts (that is, those which may require enforcement) are circled. No attempt was made to evaluate use levels beyond the 1980 paving season.

Representatives from PennDOT and the Asphalt Institute compiled their data jointly and responded from an overall state perspective of paving operations. The Bureau of Municipal Services, which allocates state

Table 8

POST-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS
IN PENNSYLVANIA IN THE NONEXEMPT OPERATIONS^a

Road Construction or Maintenance Operation	Post-RACT Use (as of May 1, 1980) from May 1 to October 31, 1980					
	PennDOT, AI and Bur. of Mun. Services	Contractor			Supplier	
		A	B	C	A	B
Aggregate-Bituminous Base Course						
Cutback	5	5	-	5	5	-
Emulsified	1	1	-	1	1	-
Soil-Bituminous Base Course						
Cutback	5	5	-	5	5	(4)
Emulsified	1	5	-	4	1	4
Bituminous Surface Course FB-2						
Cutback	5	5	-	-	5	-
Emulsified	1	2	-	-	5	2
Bituminous Surface Course FB-1						
Cutback	5	5	-	5	5	5
Emulsified	1	1	-	1	1	2
Bituminous Surface Course CP-2						
Cutback	5	5	-	5	5	5
Emulsified	1	5	-	1	1	2
Bituminous Surface Course DP-1						
Cutback	5	5	-	5	5	5
Emulsified	1	5	-	2	1	2
Bituminous Seal Coat						
Cutback	5	5	-	5	5	5
Emulsified	1	1	1	1	1	1
Bituminous Surface Treatment						
Cutback	5	5	-	5	5	5
Emulsified	1	1	1	1	1	1
Fog Seal						
Cutback	-, (3) ^b	5	-	-	5	5
Emulsified	-, 1 ^b	5	-	1	1	1
Paved Shoulders						
Cutback	5, 5 ^b	5	-	- ^c	5	5
Emulsified	1, 5 ^b	1	1	- ^c	1	2
Recycling						
Cutback	5, 5 ^b	5	-	-	5	5
Emulsified	4, 1 ^b	5	-	4	1	4

^aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

^bThe second column of values is the response of the Bureau of Municipal Services.

^cThis category is an extension of base course construction.

money to townships for paving operations, answered from a local perspective; however, their responses concerning these operations were nearly identical to those from PennDOT and the Asphalt Institute. Except for the limited fog seal work done at the township level, it is expected that emulsified asphalts will be substituted for cutback asphalts in all operations.

The variation in contractor response seen in Table 8 may be attributed to the proximity of the contractor to an emulsified asphalt supplier and the contractor's familiarity with the use of emulsified asphalts. Contractors A and C have supplies of emulsified asphalts close to their asphalt plants so that emulsified asphalts can be obtained daily. Contractor B, on the other hand, does not have suppliers of emulsified asphalts close to his plant, so the contractor must consider storage and projected demand. Although none of the contractors use cutback asphalts in the regulated season, Contractors A and C use emulsified asphalts in more types of operations than Contractor B. Contractor C has the most experience in the use of emulsified asphalts, particularly in such categories as soil bituminous base course, bituminous surface courses CP-2 and DP-1, and fog seal operations, where he is the only contractor to use emulsified asphalts. He is also experimenting with emulsified asphalts in recycling operations.

Emulsified asphalt Suppliers A and B are located in south-central and midwestern Pennsylvania, respectively. They indicated that cutback asphalts would not be used during May through October in the nonexempt operations, although Supplier B did note that there is some research and development work being done with cutback asphalts in the soil bituminous base course.

2.3.6 SOUTH CAROLINA

2.3.6.1 RACT Status in South Carolina. RACT for the use of cutback asphalts in South Carolina road construction and maintenance operations has been conditionally approved; it was proposed by the South Carolina Department of Health and Environmental Control and became effective statewide July 1, 1979⁷. RACT is found in South Carolina's revised SIP (Part G, Section II of Regulation 62.5, "Air Pollution Control Standards, Standard No. 5, Volatile Organic Compounds"). The regulation is stated below.

"Part G. Cutback Asphalt

1. For the purpose of this Part "cutback asphalt" means asphalt cement which has been liquefied by blending with petroleum solvents (dilutents).
2. No person may cause, allow or permit the use or application of cutback asphalt except as follows:
 - a. used solely as a penetrating prime coat,
 - b. long-life asphalt mix stockpile storage,
 - c. other use or application during the months of January, February, and December."

RACT was implemented in South Carolina approximately one year ago. Therefore, an evaluation of pre- and post-RACT use patterns of cutback and emulsified asphalts is possible.

The South Carolina Department of Highways and Public Transportation (SCDHPT), the Asphalt Institute, two emulsified asphalt suppliers, and one private contractor completed the bituminous-materials-use table developed

⁷RACT for cutback asphalts was submitted with other VOC regulations in South Carolina's revised SIP. To date, these VOC regulations have been conditionally approved with no change in the cutback asphalt paving regulation.

for South Carolina. Their responses appear in Appendix A (Section 4.1.6.1). A list of South Carolina's applicable road construction and maintenance operations, and a list of cutback and emulsified asphalt suppliers are also given in Appendix A (Sections 4.1.6.2 and 4.1.6.3, respectively).

2.3.6.2. Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in South Carolina. South Carolina was successfully using emulsified asphalts in a number of road construction and maintenance operations long before RACT was implemented (see Appendix A, Section 4.1.6.1). In 1946, SCDHPT was using some emulsified asphalts in maintenance and in-place mixing operations -- operations normally reserved for asphalt cements. It was in the 1947 paving season when emulsified asphalts were used in an operation which was usually performed with either asphalt cements or cutback asphalts. That year, SCDHPT placed a single surface treatment (or chip seal application) in Lexington County using an emulsified asphalt. The response at that time, in terms of resulting road quality, was that the emulsified asphalt did not perform better but was an adequate substitute. Following additional emulsified asphalt projects, contractors were given the option of using cutback asphalts, asphalt cements, or emulsified asphalts in several categories of road construction and maintenance operations.

The majority of South Carolina's road work was and still is performed with asphalt cements; the long paving season (March through November) extends the use of asphalt cements, thus limiting the use of cutback asphalts to some surface seal work, prime coat application, and occasional stockpile storage mixes. Therefore, the extensive pre-RACT use of emulsified asphalts has been mainly as a substitute for asphalt cements, rather than cutback asphalts.

The sales of cutback and emulsified asphalts in South Carolina from 1969 through 1978 are shown below in Figure 7.

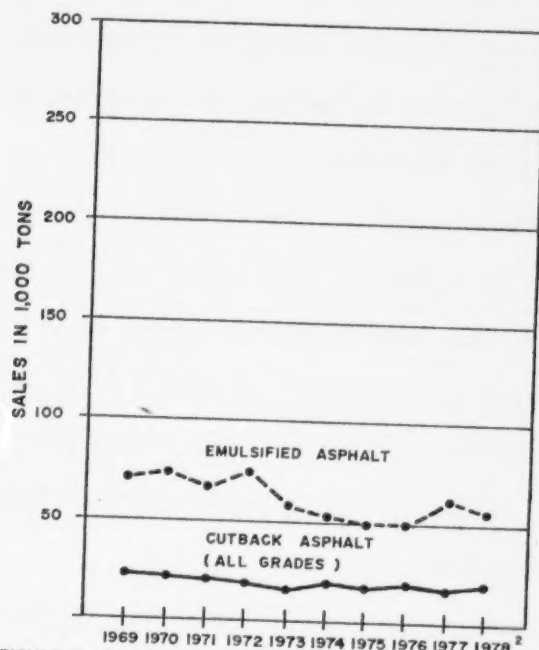


FIGURE 7. Cutback and emulsified asphalt sales in South Carolina¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

There has been little fluctuation in the sales of cutback asphalts over the ten-year period, whereas the sales of emulsified asphalts, which were approximately three times greater than those of cutback asphalts in 1978, have varied to some extent.

In this case the use of emulsified asphalts cannot be completely attributed to substitution for cutback asphalts; three factors were primarily responsible for pre-RACT substitution efforts. First, the workers found that emulsified asphalts are safer products to use. Second, the price of emulsified asphalts, according to the respondents, has been and remains

competitive with the price of cutback asphalts. Today, the price of emulsified asphalts is anywhere from \$.13 to \$.26 per gallon less than cutback asphalts depending on the grades selected. Finally, emulsified asphalts are more convenient to use, specifically in multiple surface treatments (known in South Carolina as bituminous surfacing: single and double treatments). The common practice prior to the use of emulsified asphalts was to use two distributor trucks in the field -- one filled with an asphalt cement and one filled with a cutback asphalt. The asphalt cements were sprayed onto the road surface followed by a layer of aggregate; this process continued with aggregate size decreasing towards the top cover, which consisted of a spray application of cutback asphalts with perhaps a cover of fine aggregate. The use of emulsified asphalts required only one distributor truck because the emulsified asphalts, in this operation, were adequate substitutes for both asphalt cements and cutback asphalts.

Pre-RACT formal training programs, like those instituted in other states, were not required because nearly all of the paving is done by private contractors who had been using emulsified asphalts for about forty years.

2.3.6.3 Post-RACT Use Patterns of Cutback and Emulsified Asphalts in South Carolina. Extensive pre-RACT use of emulsified asphalts, although not exclusively as a substitute for cutback asphalts, has enabled South Carolina to implement RACT with relatively little effort. The projected use of cutback and emulsified asphalts in South Carolina from March 1 through November 30, 1980 in the nonexempt road construction and maintenance operations is shown in Table 9. The only road construction and maintenance operation which may require enforcement is the cold-laid asphaltic concrete mix used as an immediate source of patch material.

Table 9

POST-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS
IN SOUTH CAROLINA IN THE NONEXEMPT OPERATIONS^a

Road Construction or Maintenance Operation	Post-RACT Use (as of July 1, 1979) from March 1 to November 30, 1980			
	SCDHPT and AI	Contr. A	Supp. A and Contr. B	Supp. B
Road Mix Sand Asphalt Base Course				
Cutback	5	5	5	5
Emulsified	5	5	5	1
Cold Laid Asphaltic Concrete Binder Course				
Cutback	5	5		5
Emulsified	5	5	b	5
Cold Laid Asphaltic Concrete Surface Course				
Cutback	5	5		5
Emulsified	5	5	b	5
Bituminous Surfacing (Single Treatment, Types 1,3,2,4, and 5)				
Cutback	5	5	5	5
Emulsified	1	1	1	1
Bituminous Surfacing (Double Treatment, Types 1,2,3, and 4)				
Cutback	5	5	5	5
Emulsified	1	1	1	1
Bituminous Surfacing (Triple Treatment, Types 1,2,3,4, and 5)				
Cutback	5	5	5	5
Emulsified	1	1	1	1
Fog Seal				
Cutback	5	5	5	5
Emulsified	5	5	1 ^c	5
Tack Coat				
Cutback	5	5	5	5
Emulsified	1	1	1	1
Patch Material				
Immediate Use				
Cutback	②	5	①	5
Emulsified	1	5	1	5
Paved Shoulders				
Cutback	5		5	5
Emulsified	4	d	1	5
Dust Palliative				
Cutback	5	5	5	5
Emulsified	5	5	5	1

^aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

^bSee patch material immediate use for cutback and emulsified asphalt use levels.

^cThe respondent referred to a fog seal material as a crack sealant.

^dSee bituminous surfacing: single treatment for cutback and emulsified asphalt use levels.

The SCDHPT and the Asphalt Institute reviewed the bituminous-materials-use table together and responded from an overall view of statewide road construction and maintenance operations. They indicated that cutback asphalts were used only in prime coat applications and stockpile mixes (both of which are exempt, see Appendix A, Section 4.1.6.1) and in some mixes for immediate use as patch material.

Contractor A, who does much of the road construction and maintenance work in the southern part of the state, and Supplier B, from South Carolina, did not cite the use of cutback asphalts in any of the nonexempt operations.

Supplier A was assisted by Contractor B (who does most of his paving in the northern part of the state) in estimating use levels of cutback and emulsified asphalts. According to them, cutback asphalts are generally used in the cold-mixed patch material for immediate use.

2.3.7 TEXAS

2.3.7.1 RACT Status in Texas. As a result of EPA's conditional approval on March 25, 1980, RACT for Texas is presently being revised by the Texas Air Control Board to include all ozone nonattainment counties in Texas which emit more than 100 tons per year of VOC from cutback asphalt paving operations. These counties include Bexar, Brazoria, Dallas, El Paso, Galveston, Harris, Jefferson, Nueces, Orange, and Tarrant. The regulation which is to be submitted in Texas' revised SIP and implemented by December 31, 1982, appears in Chapters 131.01 and 131.07 of the Texas Air Control Board's Regulation V, Control of Air Pollution from Volatile Organic Compounds (Subchapters 00 and 59, respectively). Subchapter 00 (Rule 001) defines cutback asphalt and Subchapter 59 (Rules 101 and 105) outlines use restrictions and compliance requirements as follows:

00.001 (54)A "Cutback Asphalt. Any asphaltic cement which has been liquefied by blending with petroleum solvents (dilutents).

59.101. "CUTBACK ASPHALT (as defined under specified solvent-using processes in the General Rules). The use of cutback asphalt containing volatile organic compound solvents for the paving of roadways, driveways or parking lots is restricted to no more than 8 percent of the total annual volume averaged over a two-year period of asphalt used or specified for use by any state, municipal or county agency who uses or specifies the type of asphalt application".

59.105. "COMPLIANCE SCHEDULE AND COUNTIES. (a) The provisions of the first rule (131.07.59.101) shall apply only within Harris County. All affected persons shall be in compliance with the rule as soon as practicable, but no later than December 31, 1982 and shall submit a final control plan for compliance to the Texas Air Control Board no later than December 1, 1980."

Unlike RACT in other states, Texas' RACT does not restrict the use of cutback asphalts in any operation or specify the amount of solvent in

emulsified asphalts. Instead, it limits the use of cutback asphalts to a fixed percentage of all asphalt used in paving operations (for a given nonattainment area). Because Texas' proposed RACT implementation date, December 31, 1982, will occur following the writing of this report, it is possible to evaluate only pre-RACT use patterns of cutback and emulsified asphalts. Pre-RACT use levels were determined for three major nonattainment areas in Texas: the Austin area, including Travis and Bexar Counties; the Dallas and Fort Worth area, including Dallas and Tarrant Counties; and the Houston area, including Brazoria, Harris, and Galveston Counties.

The Texas Highway Department (THD), the Asphalt Institute, county highway departments in each of these areas, and local contractors and emulsified asphalt suppliers provided information for evaluating existing use patterns of cutback and emulsified asphalts in Texas. A list of Texas road construction and maintenance operations in which cutback or emulsified asphalts are used and a list of cutback and emulsified asphalt suppliers are given in Appendix A (Sections 4.1.7.1 and 4.1.7.2, respectively).

2.3.7.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Texas. The use of emulsified asphalts varies geographically. In the Austin, Dallas, and Fort Worth areas emulsified asphalts are utilized to some extent, in all mix and spray paving categories except in prime coat applications, stockpile patch mixes, and aggregate precoat work, whereas in the three-county Houston area, the use of emulsified asphalts is limited. According to some respondents, high humidity may be an inhibiting factor in Texas' coastal areas.

THD began substituting emulsified asphalts for cutback asphalts in some seal coat work and stabilization mixes in the 1930's. Later applications

included dust palliative and fog seal work. By 1935 THD had specified the use of emulsified asphalts in several categories of road construction and maintenance operations that normally required the use of either asphalt cements or cutback asphalts.

The use of emulsified asphalts was generally low through the 1950's and early 1960's. By the mid-1960's several emulsified asphalt suppliers had established themselves in Texas and had introduced the cationic emulsified asphalts. These were effective replacements for cutback asphalts in some chip seal work. The sales of cutback and emulsified asphalts in Texas from 1969 through 1978 is shown below in Figure 8.

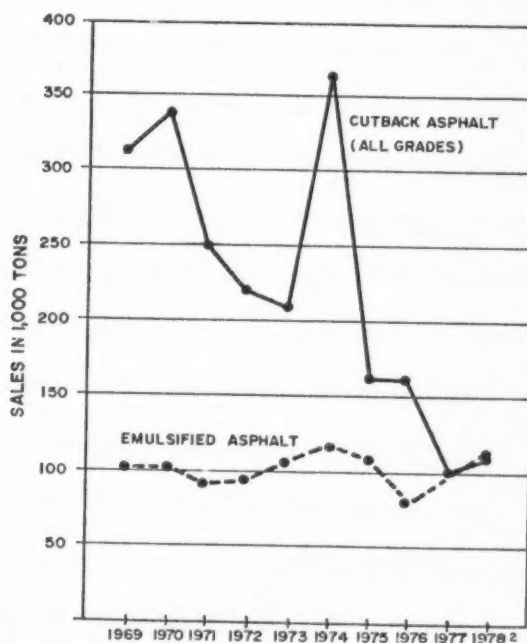


FIGURE 8. Cutback and emulsified asphalt sales in Texas ¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

The sales pattern shows that cutback asphalts exceeded emulsified asphalts in 1969 by approximately a three-to-one ratio. By 1978, the sales of emulsified asphalts were slightly larger than those of cutback asphalts.

Over the past couple of years some emulsified asphalt training sessions have taken place. On a large scale, the FHWA, the Asphalt Institute, the American Public Works Association, and Texas A & M University have either sponsored or presented emulsified asphalt emulsion workshops. On a smaller scale, several emulsified asphalt suppliers have presented instructional sessions to THD's construction and maintenance crews as well as supervisory personnel.

The pre-RACT use of cutback and emulsified asphalts in Texas road construction and maintenance operations is projected for the 1980 paving season in Table 10. Values representing continued use of cutback asphalts are circled. Each circled value does not, by itself, represent an enforcement problem for a given nonattainment area; a group of circled values, however, could represent an enforcement problem for an area if the total use of cutback asphalts exceeds eight percent of the use of the total liquid asphalts in that area (averaged over two years). No attempt was made to project use levels resulting from RACT implementation, effective December 31, 1982.

A state-wide accounting of the existing use of cutback and emulsified asphalts was provided by the Asphalt Institute's District Engineer in Texas. He noted that cutback asphalts are generally-to-sometimes used in all road construction and maintenance operations.

Some emulsified asphalts are used in all road construction and maintenance operations evaluated for the Austin area. THD, which is the largest user of emulsified asphalts in the area, stated that the use of emulsified asphalts is becoming more widely accepted in seal and prime coat

Table 10

PRE-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS IN TEXAS

Road Construction or Maintenance Operation	Pre-RACT Use for the 1980 Paving Season									
	Austin Area			Houston Area			Dallas and Fort Worth Area			
	AI	THD	Contr.	THD	City #12	County A	County B	THD	County A	County B
								#2	#18	Contr. Supp.
Stabilization Mixes (Road and Plant Mixes)										
Cutback	①	5	5	③	5	5	5	5	③	③
Emulsified		2	5	①	5	5	5	5	3	5
Surface Treatments and Seal Coats (One, Two, and Three Course Surface Treatments)										
Cutback	②	②	5	③	5	①	①	②	②	②
Emulsified			1	①	5	2	5	2	2	③
Fog Seal										
Cutback	-	5	5	5	5	5	5	③	5	5
Emulsified	-	1	5	1	5	5	5	①	5	5
Prime Coat										
Cutback	①	①	①	①	5	5	①	①	③	②
Emulsified	4	2	5	5	5	5	5	3	3	③
Tack Coat										
Cutback	①	①	①	③	①	①	①	①	③	③
Emulsified	2	2	3	①	5	5	5	3	③	①
Patch Material: Immediate Use										
Cutback	①	③	5	5	①	①	①	5	5	5
Emulsified	5	3	5	1	5	5	5	5	5	3
Stockpile										
Cutback	①	①	5	①	5	①	①	③	③	①
Emulsified	5	3	5	3	5	5	5	5	5	5
Paved Shoulders										
Cutback	-	b	5	5	5	5	5	5	5	5
Emulsified	-		5	1	5	5	5	5	5	5
Dust Palliative										
Cutback	①	5	5	③	①	①	①	5	5	5
Emulsified	1	1	5	①	5	5	5	5	5	1

(Continued)

a, where 1 = generally used
2 = sometimes used
3 = used on a selected or trial basis
4 = currently not used but in research and development stage
5 = never used
and the values circled represent operations which may require additional enforcement.

Asphalt shoulder is included under the surface treatments and seal coats category.

applications, although THD still uses cutback asphalts in stabilization mixes and fog seal applications. The Austin contractor who was contacted does not use much cutback or emulsified asphalts. The emulsified asphalt supplier mentioned that the cost advantage of emulsified asphalts for the Austin area has been, in part, responsible for some of the recent substitution efforts.

The Houston area uses emulsified asphalts only in some surface treatment and seal coat work, as cited by THD District 12. Some respondents explained that the use of emulsified asphalts along the Gulf Coast is inhibited because of the high humidity which prevents or severely delays the setting of the emulsified asphalts (see Table 10, page 65). Consequently, several days may be necessary for the water to evaporate from an emulsified asphalt road mix or surface treatment subjecting the work to washout by rain.

The switch to emulsified asphalts in the Dallas and Fort Worth area follows the trend in the Austin area more closely than in the Houston area. THD Districts 2 and 18 have had much success using emulsified asphalts in surface treatments and seal coats. Presently, these districts in the Dallas and Fort Worth area estimate their combined use of cutback asphalts to be from seven to ten percent of the total use of liquid asphalts. The use of emulsified asphalts by the respective precincts in each county highway department varies; some use a limited amount of emulsified asphalts because of unfamiliarity or previous bad experiences in working with the material or distance from suppliers, whereas others use emulsified asphalts exclusively. The contractor in this area generally uses emulsified asphalts in dust palliative and aggregate precoat work and on a selected basis for

prime coat applications. The supplier noted that emulsified asphalts are being used at least as extensively as cutback asphalts in every road construction and maintenance operation except prime coat applications, stockpile mixes, and aggregate precoat work.

2.3.8 WISCONSIN

2.3.8.1 RACT Status in Wisconsin. As of May, 1980, Wisconsin's RACT for the use of cutback asphalts in road construction and maintenance operations has not been approved by EPA; it was submitted by the Air Impact Analysis Section of Wisconsin's Department of Natural Resources (WDNR) and was approved by the state legislature in January 1979. Wisconsin's RACT is a three step approach designed to phase-out cutback asphalt use in the state and has been implemented statewide. The regulation appears in Appendix 11-C-1-1 of Wisconsin's revised SIP, "A Statewide Implementation Plan to Achieve Air Quality Standards for Particulates, Sulfur Oxides, Nitrogen Oxides, Hydrocarbons, Oxidants, and Carbon Monoxide in the State of Wisconsin." The sections pertaining to cutback asphalts are taken from Wisconsin's Administrative Code, Chapter NR 154, Air Pollution Control (Chapter NR 154.01 and 154.143(5)).

In Chapter NR 154.01, "Cutback asphalt means asphalt cement which has been liquefied by blending with petroleum solvents (dilutents) other than residual oils. Upon exposure to atmospheric conditions, the dilutents evaporate, leaving the asphalt cement to perform its function. Emulsified asphalt which contains less than 5 percent by weight petroleum solvents (disregarding any residual oils added) are not included in this definition." The cutback asphalt paving regulation is found in Chapter NR 154.13(5) and reads as follows:

"(5) USE OF ROAD SURFACING MATERIALS (a) Cutback Asphalts. 1. Applicability. a. Paragraph (5)(a) applies to the mixing, storage, use and application of cutback asphalts in Wisconsin. Paragraph (5)(a) does not apply to cutback asphalts intended for uses other than application to surfaces traversed by motor vehicles, bicycles

or pedestrians. 2. The following restrictions apply to the mixing, open storage, use or application of cutback asphalts during the ozone season:

- a. After July 1, [August 1] 1979, the use of rapid curing cutback asphalts shall not be permitted.
- b. After May 1, 1980, the use of cutback asphalts for seal coating operations shall not be permitted except where a single coat of liquid asphalt is applied to an aggregate base to control dust.
- c. After May 1, 1981, the use of cutback asphalts shall not be permitted except for the aggregate base application allowed in (5)(a)2.b, and for use as a penetrating prime coat during the first and last months of the ozone season."

Basically, the regulation which is now in effect eliminates the use of RC cutback asphalts in all operations and MC cutback asphalts in seal coat work (except as a dust palliative); the use of SC cutback asphalts is also exempt by definition (because they are manufactured with residual oils). By 1981, the use of MC cutback asphalts will be further restricted in the ozone season (May 1 through September 30) to dust palliative work and prime coat applications; the use of MC cutback asphalts in mix operations will be discontinued at that time. Since RACT was implemented in Wisconsin on May 1, 1980 (under Wisconsin's Administrative Code, Chapter NR 154), it was possible to evaluate pre- and post-RACT use patterns of cutback and emulsified asphalts.

The Wisconsin Department of Transportation (WDOT), the Asphalt Institute, two county highway departments, one contractor, and one emulsified asphalt supplier completed the bituminous-materials-use table developed for Wisconsin. Their responses have been tabulated in a composite bituminous-materials-use table which appears in Appendix A (Section 4.1.8.1). A list of Wisconsin road construction and maintenance operations, with the grades of cutback and emulsified asphalts that WDOT specifies for use in the operations,

and a list of cutback and emulsified asphalt suppliers which serve Wisconsin, are also given in Appendix A (Sections 4.1.8.2 and 4.1.8.3, respectively).

2.3.8.2 Pre-RACT Use Patterns of Cutback and Emulsified Asphalts in Wisconsin. Wisconsin has historically had problems in substituting cutback asphalts with emulsified asphalts. The first attempt occurred in 1973. The Wisconsin Department of Transportation (WDOT) ran an SS-1 emulsified asphalt through a travel plant which left a mixed windrow of aggregate and emulsified asphalt on the road surface. The four to five percent moisture content in the mixed windrow created problems in compaction; before the job was completed, a 2-1/2 inch rainstorm washed out the sections of windrow that had not been spread and ravelled the mix that had been compacted. The job failure may have been attributed to poor technical advice given by the emulsified asphalt manufacturer. (According to one county representative, emulsified asphalts were being marketed at that time as products which could work better than cutback asphalts in rain and cold weather.) This initial attempt marked the beginning of several failures in Wisconsin road mix operations resulting from the improper use of emulsified asphalts. Consequently, the use of emulsified asphalts throughout the state remains at a relatively low level except in a few counties where effective training in the use of emulsified asphalts has taken place and successful jobs have been completed. The trend in the sales of cutback and emulsified asphalts from 1969 through 1978 is shown in Figure 9.

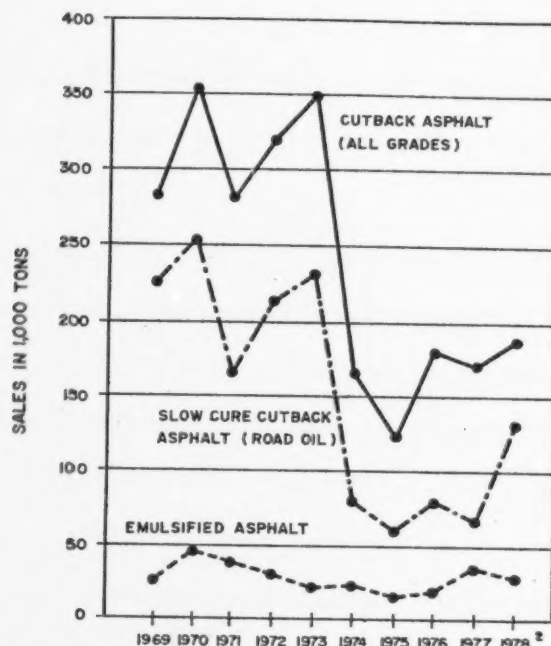


FIGURE 9. Cutback and emulsified asphalt sales in Wisconsin¹

¹ This information has been taken from the "Annual Report of Asphalt Sales" prepared by the U.S. Department of Energy (1976 through 1978) and the U.S. Bureau of Mines (1969 through 1975).

² 1978 Estimates are not revised.

The line representing SC cutback asphalt sales should be noted. Based on these sales data, RACT's exemption of SC cutback asphalts may prove to be a significant easement in terms of RACT compliance for uses of cutback asphalts in Wisconsin.

Through 1979, WDOT has not had a completely successful road mix operation using emulsified asphalts and has not really encouraged the use of emulsified asphalts to any extent. Successful pre-RACT use of emulsified asphalts has occurred, however, in some Wisconsin counties outside of WDOT jurisdiction.

Wisconsin's county highway departments play a significant role in statewide road construction and maintenance operations. The counties, about

16 of which own and operate hot mix plants, have jurisdiction over approximately 88 percent of Wisconsin's 105,000 miles of road. In addition to their city and township work, they perform nearly all of the maintenance on state roads.

The Portage County Highway Department, which began seal coating with high float emulsified asphalts in 1977, purchased a pugmill in 1978 to increase the use of emulsified asphalts in road mix operations. By 1979 they had determined the optimum aggregate moisture content to be three percent when using emulsified asphalts in mix operations and found that if the moisture content could be kept below five percent, road quality would not be impaired. Their emulsified asphalt work has been successful, which is due, partly, to the technical assistance they received from one local emulsified asphalt manufacturer. Upon request by some of the counties, an asphalt emulsion workshop was conducted in the spring of 1979 in Stevens Point, Wisconsin, at which the eight highway districts were represented. There are now about six counties which have purchased pugmills for emulsified asphalt work.

With the exception of the seminar conducted at Stevens Point, group training sessions on the use of emulsified asphalt in Wisconsin have been limited to a few technical presentations given at Marquette University in Milwaukee. Therefore, it appears that Wisconsin may have much difficulty in implementing RACT; however, RACT presently exempts the use of SC cutback asphalts, which are the primary cutback asphalts used in the state by the county highway departments. The exemption thus provides a buffer for the majority of cutback asphalt users in the state.

2.3.8.3 Post-RACT Use Patterns of Cutback and Emulsified Asphalts in Wisconsin. Despite the large quantities of SC cutback asphalts used in Wisconsin (see Figure 9, page 72), enforcement problems may exist for all nonexempt road construction and maintenance operations in Wisconsin. In many cases, the switch to emulsified asphalts has been avoided due to numerous bad pre-RACT experiences with emulsified asphalts.

The projected use of cutback and emulsified asphalts in Wisconsin from May 1 through September 30, 1980 in the four currently nonexempt road construction and maintenance operations, is shown in Table 11. Values representing continued use of cutback asphalts are circled to highlight operations which may require enforcement (low SC cutback values representing use levels of SC cutback asphalts are not circled because they are presently exempt). No attempt was made to predict use levels resulting from RACT, which is effective May 1, 1981.

WDOT, the Asphalt Institute, and County A (one of the more progressive counties in the acceptance of emulsified asphalts) indicated that there are no cutback asphalts used in seal coat and aggregate precoat work or fog seal and tack coat applications.

County B, which can be classified as a rural county, noted that cutback and emulsified asphalts are used on an equal basis in seal coat work, however, they are or v being used in the reasearch and development stage.

The contractor, who has used MC grades of cutback asphalts in all of the nonexempt operations stated that he is continuing this pattern for the 1980 season because of past success with cutback asphalts.

The supplier also indicated that cutback asphalts are used in seal coat operations but only on a selected or trial basis.

Table 11

POST-RACT USE OF CUTBACK AND EMULSIFIED ASPHALTS
IN WISCONSIN IN THE NONEXEMPT OPERATIONS^a

Road Construction or Maintenance Operation	Post-RACT Use (as of May 1, 1980) from May 1 to September 30, 1980					
	AI	WDOT	County		Contractor	Supplier
			A	B		
Seal Coat						
Cutback	5	5	5	④	①	③
Emulsified	1	1	1	4	2	1
Fog Seal						
Cutback	5	5	5	5	①	5
Emulsified	1	1	5	5	2	1
Bituminous Tack Coat						
Cutback	5	5	5	1 ^b	①	5
Emulsified	1	2	5	5	2	1
Aggregate Precoat						
Cutback	5	5	5	5	①	5
Emulsified	2	5	5	5	3	5

^aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used

and the values circled represent operations which may require additional enforcement.

^bThe cutback asphalt used by county B for tack coat operations is SC-800.

2.4 Eight-State Summary of RACT Status and Implementation Effort

The preceding investigation into the RACT status and pre- and post-RACT use patterns of cutback and emulsified asphalts in California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin has shown that the content and implementation of RACT will vary from state to state. RACT is summarized for each state in Table 12, and the reasons for the continued use of cutback asphalts in each state, noting the road construction and maintenance operations that may require enforcement, are discussed below.

In certain areas of California's mountain, coastal, and desert regions, cutback asphalts are used in nearly all road construction and maintenance operations. Steep and winding roads, temperature and humidity extremes have curtailed the pre- and post-RACT use of emulsified asphalts. Consequently, in some areas of California, adverse climate or topography may present problems in fully implementing RACT.

Colorado's pre-RACT emulsified asphalt use has also been influenced by meteorological conditions. Areas of high elevation (where precipitation is frequent) and areas of low humidity have relied heavily on cutback asphalts, although much of this use is in exempt operations. There is a trend toward increased use of emulsified asphalts, especially because of the RACT phase-in option, which allows a one-year compliance date extension. By the time of RACT implementation, the use of cutback asphalts in nonexempt operations should be confined mainly to immediate-use patch material in areas of adverse weather.

Indiana's extensive pre-RACT use of emulsified asphalts should minimize RACT-implementation effort. Most of the remaining cutback asphalt use

Table 12

EIGHT-STATE SUMMARY OF RACT STATUS

State	Implementation Date(s)	Applicability	EPA Approval	Exemptions
CAa	7/1/79 7/1/80 1/1/82	22 of 43 APCDs (35 of 58 counties)	Varies ^b	-- use of MC and SC cutback asphalts -- road construction and maintenance operations on days less than 50 F (10 C) and in prime coat applications -- SC cutback asphalts with less than 0.5 percent solvent and emulsified asphalts with less than 3 percent solvent
CO	12/31/81 ^c	Arapahoe Co. Adams Co. Boulder Co. Denver Co. Douglas Co. Jefferson Co.	Pending as of 7/80	-- road construction and maintenance conducted October through April and in prime coat applications
IN	1/20/80	Statewide	Pending as of 6/80	-- road construction and maintenance operations conducted November through March and in prime coat applications and stockpile storage mixes
MO	1/1/83	Clay Co. Franklin Co. Jackson Co. Jefferson Co. Platte Co. St. Charles Co. St. Louis City St. Louis Co.	Approved 4/80	-- plant mix or road mix for filling potholes or for emergency repair; plant mix for use outside of regulated areas; prime coat applications; seal coat work; and road construction and maintenance operations conducted October through April
PA	1/1/80	Statewide	Conditionally approved 5/80 ^d	-- road construction and maintenance operations conducted November through April and in prime coat and tack coat applications, dust palliative, aggregate precoat, and protective concrete coat work.

Table 12

EIGHT-STATE SUMMARY OF RACT STATUS

State	Implementation Date(s)	Applicability	EPA Approval	Exemptions
CA ^a	7/1/79 7/1/80 1/1/82	22 of 43 APCDs (35 of 58 counties)	Varies ^b	-- use of MC and SC cutback asphalts -- road construction and maintenance operations on days less than 50 F (10 C) and in prime coat applications -- SC cutback asphalts with less than 0.5 percent solvent and emulsified asphalts with less than 3 percent solvent
CO	12/31/81 ^c	Arapahoe Co. Adams Co. Boulder Co. Denver Co. Douglas Co. Jefferson Co.	Pending as of 7/80	-- road construction and maintenance conducted October through April and in prime coat applications
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MO	1/1/83	Clay Co. Franklin Co. Jackson Co. Jefferson Co. Platte Co. St. Charles Co. St. Louis City St. Louis Co.	Approved 4/80	-- plant mix or road mix for filling potholes or for emergency repair; plant mix for use outside of regulated areas; prime coat applications; seal coat work; and road construction and maintenance operations conducted October through April
PA	1/1/80	Statewide	Conditionally approved 5/80 ^d	-- road construction and maintenance operations conducted November through April and in prime coat and tack coat applications, dust palliative, aggregate precoat, and protective concrete coat work.

is in road mixes, seal coats, and dust palliative work by the county highway departments in northern Indiana, where experience with emulsified asphalts has been limited.

RACT will not be implemented in Missouri for another two and a half years. By that time, emulsified asphalts should be widely used in the two metropolitan areas subject to RACT. Cutback asphalt use is limited mainly to road mixes and dust palliative work and some tack coating. Continued preferential use of cutback asphalts by some users may result in enforcement problems.

As a consequence of Pennsylvania's educational programs on the advantages of emulsified asphalts, the use of cutback asphalts has been minimized. Users of cutback asphalts indicated that cutback asphalts are used only in fog seal work at the local level, and only on a limited basis. Proposed revisions to Pennsylvania's RACT would delete the exemptions for tack coat and protective coating for concrete. Cutback asphalts are not used appreciably in these operations, therefore, there should be little difficulty implementing RACT in Pennsylvania.

Favorable climate and the extensive use of asphalt cements in South Carolina have resulted in minimal cutback asphalt use. The only continued use of cutback asphalts appears to be in cold-laid mixes for immediate-use patch material.

In Texas, cutback asphalts are used at least to some degree in all categories of road construction and maintenance. The use of emulsified asphalts is on the rise in most parts of the state. Along the Gulf Coast, however, the use of emulsified asphalts has not developed because of high humidity. While most state and county highway departments should not have difficulty meeting the cutback asphalt limit (eight percent of all asphalt

used, on a county-by-county basis), those situated in coastal areas will, most likely, have some difficulty unless emulsified asphalts can be shown to perform adequately in that climate.

Wisconsin's pre-RACT use of emulsified asphalts was hindered by the poor performance of these asphalts in state-funded jobs. The counties, which represent almost 90 percent of Wisconsin's road jurisdiction, have had better results. Some users who have not had success with emulsified asphalts may be reluctant to switch to them. In addition, training in the use of emulsified asphalts has been limited in Wisconsin. Therefore, Wisconsin may experience some problems in the complete implementation of RACT.

3.0 EQUIPMENT CHANGES

3.1 Introduction

The implementation of RACT will not entail extensive or costly equipment changes based on our discussions with equipment manufacturers and dealers and with users and producers of cutback and emulsified asphalts. The only observed equipment change was minor and involved asphalt pumps; however, several storing and handling procedures have been developed specifically for the use of emulsified asphalts. This section describes the potential changes in asphalt pumps and summarizes key storing and handling procedures for emulsified asphalts following a brief description of the manufacture and application of cutback and emulsified asphalts.

3.1.1 Manufacture of Cutback and Emulsified Asphalts.

A typical materials flow chart of cutback and emulsified asphalts used in road construction or maintenance operations is shown in Figure 10. The chart begins at the manufacturing site and ends at the paving job site. Cutback asphalts are usually manufactured at petroleum refineries and basically require the blending of an asphalt cement with a petroleum solvent. Emulsified asphalts may also be manufactured at refineries but are most often manufactured in separate plants, logistically positioned with respect to product demand, transport facilities, and ingredient suppliers. Emulsified asphalts are made in a colloid mill in which rotary action shears heated asphalt cement into fine particles, and combines them with water which has

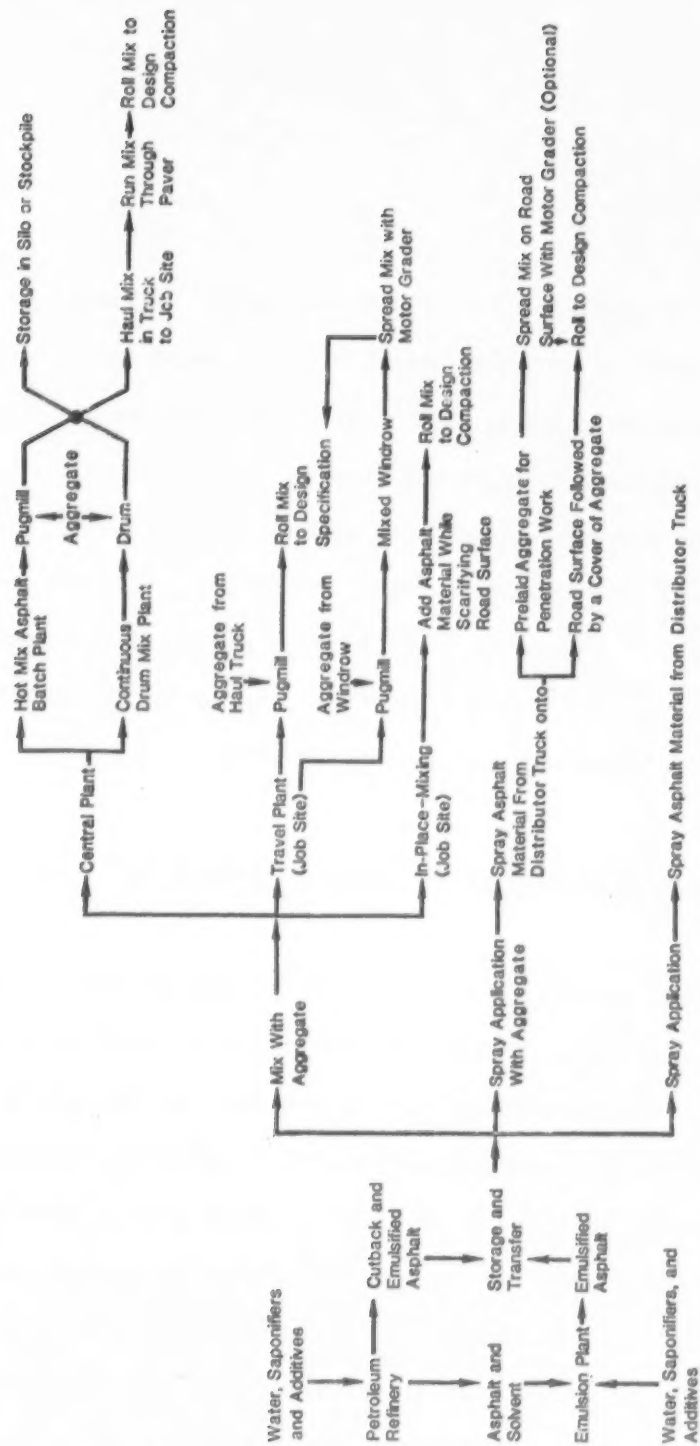


Figure 10. Cutback and emulsified asphalt flow chart

been treated with surfactants and other additives (sometimes including varying amounts of solvents).

3.1.2 Application of Cutback and Emulsified Asphalts.

As shown in Figure 10, cutback and emulsified asphalts can be mixed with aggregate, applied as a spray application followed by an aggregate cover, or applied as a spray application alone. In general, cutback and emulsified asphalts can be either mixed at a central location with aggregate at ambient temperature or with aggregate that has been preheated to a range of temperatures nominally between 100 and 150 F (38 and 65.5 C), or at the paving job site with aggregate at ambient temperatures. Conventional hot mix batch plants and continuous drum mix plants are usually at a central location; the elevated mixing temperature allows the finished mix to be hauled to the paving job site and still remain workable. Travel plants and in-place-mixers are used at the paving job site to produce mixes.

Cutback and emulsified asphalts can also be used at the job site as a surface spray application. They can be sprayed onto an uncompacted upper base material and blade-mixed with a motor grader; sprayed onto an existing road surface and covered with one or more layers of aggregate chips; and sprayed without any aggregate mixing or covering serving as a prime or tack coat, crack sealant or fog seal.

3.2 Potential Changes in Asphalt Pumps

The only equipment change at the cutback and emulsified asphalt user-level due to RACT implementation involves the asphalt pump. When a cutback asphalt pump is converted to emulsified asphalt use, the pump changes include decreasing pump speed, increasing clearance between the internal moving parts of the pump, drilling holes through the idler and bushing of the pump, and flushing the pump with an oil. These changes are made to minimize pump malfunctions resulting from premature coalescence of the asphalt particles (that is, separation of the asphalt phase and water phase of the emulsified asphalt).

Pump selection is based on the physical properties of the liquid and operating conditions under which the liquid is pumped. Viscosity, specific gravity, and vapor pressure are some of the liquid variables; and capacity, discharge pressure, suction, temperature, and duty cycle are some of the operating variables considered in selecting a pump. Cutback and emulsified asphalts have different fluid flow characteristics. Specifically, cutback asphalts are Newtonian fluids (fluids in which the viscosity is constant at a given temperature which does not vary with the rate of shear), whereas emulsified asphalts are non-Newtonian fluids (fluids in which the viscosity varies with the rate of shear. In most instances the same pump can be used to transfer both bituminous materials; however, it may be necessary to make internal changes in the pump or modify its operation when switching from a Newtonian to a non-Newtonian fluid.

Positive displacement rotary pumps are used to transfer cutback and emulsified asphalts from storage containers either to a mixing unit or

through a spray distribution system. A schematic of an internal gear pump, which is a type of positive displacement rotary pump (with a single rotor) commonly used to pump asphalt material, is shown in Figure 11.

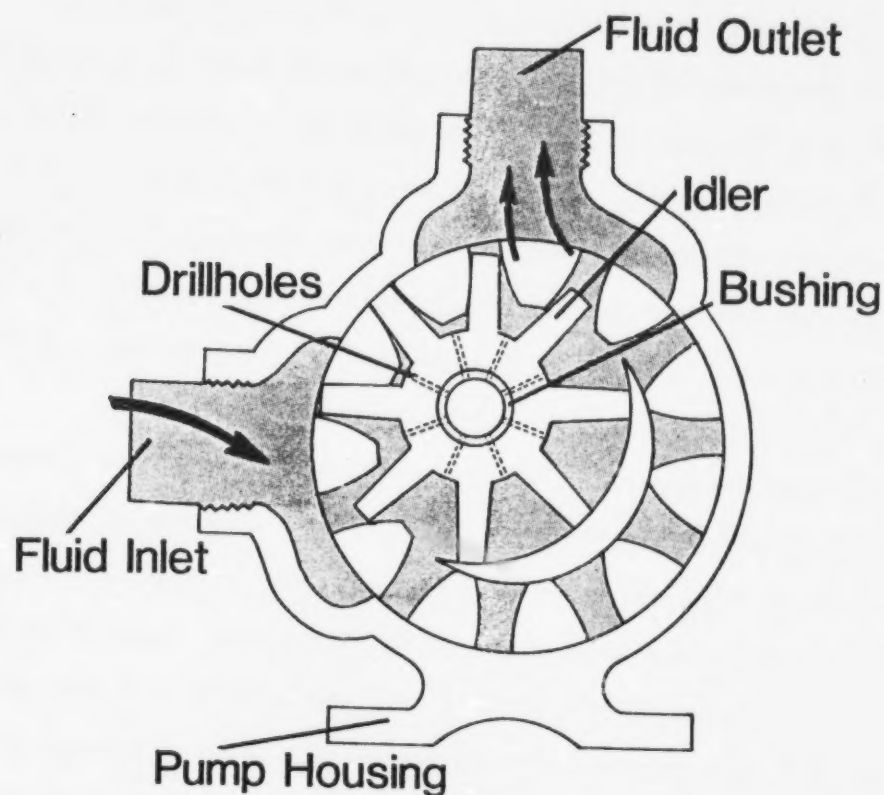


Figure 11. Schematic of a rotary positive displacement pump

A gear pump consists of a pair of meshing gears that rotate in a housing. As the fluid moves into the inlet region, it is trapped between the gear teeth keeping the fluid from passing back into the inlet region and carrying it around to the outlet side. The pressure in the outlet side increases until it is high enough to discharge the fluid.

Pump manufacturers and users recommend that the pump speed, which is normally determined by the viscosity at the pumping temperature, be reduced by approximately one-half, thus proportionately decreasing the output. As an example, a pump running cutback asphalts at 350 rpm with a 200 gpm output would likely run emulsified asphalts at 175 rpm with a 100 gpm output.

Shear pressures induced by the pumping action (that is, a squeezing action) can cause the asphalt to coalesce prematurely, forming a build-up of asphalt within the pump body. This, in turn, decreases the axial and diametric clearances between the internal rotational and stationary housing parts and between the rotational parts themselves. Consequently, all applicable clearances have to be slightly increased when handling emulsified asphalts. A typical increase would be 0.003 inch.

To further minimize malfunctions resulting from premature coalescence of the asphalt particles within the pump body, pump flushing and hole drilling through the idler and bushing may be necessary. The purpose of hole drilling is to improve lubrication between the shaft and bushing. Pumps which have been in service for a long time usually have enough frictional wear which automatically allows the fluid to move with less resistance between the moving parts. However, in some of the newer pumps which have fewer hours of operation, hole drilling may be required. The holes are about one-quarter of an inch in diameter and are drilled at each indentation of the idler gear through the bushing (see Figure 11). This can readily be performed by the user. New pumps now come equipped with predrilled holes so that either cutback or emulsified asphalts can be run through the unit.

In practice, pumps are flushed infrequently, usually at the beginning and end of the paving season regardless of whether cutback or emulsified asphalts are used. However, when pumping emulsified asphalt, it may be necessary to flush the pump with a distillate oil just before it is turned off and prior to start-up, especially in the case of emulsified asphalts containing no solvent.

3.3 Emulsified Asphalt Storing and Handling Procedures.

Changes in storage equipment will most likely occur at the cutback and emulsified asphalt manufacturer-level, although several emulsified asphalt storing and handling procedures at the user level have been developed. These procedures, which are consistent with the comments and suggestions offered by the equipment manufacturers and dealers as well as the users of cutback and emulsified asphalts interviewed in this study, are listed below.

- o Storing or handling emulsified asphalts below the freezing point or above the boiling point of water will cause the emulsified asphalts to separate into an asphalt phase and a water phase. The recommended range of storage temperatures is from 50 F (10 C) to 185 F (85 C).
- o Long-term storage of emulsified asphalts (which is more applicable to the emulsified asphalt manufacturer than to the user) can lead to asphalt settlement in the tank and to the formation of an oxidized "skin" on the surface of the product. To minimize these problems several options are available: in-tank propellers

can be used to gently circulate (or roll-over) the emulsified asphalts; circulation pumps can be used to move the emulsified asphalts from the top of the tank to the bottom -- pumping in this manner avoids surface splashing which may cause the emulsified asphalts to foam; oil can be sprayed onto the emulsified asphalt surface in the tank to reduce oxidation; and vertical storage tanks can be used so that less emulsified asphalt surface area is exposed to the tank atmosphere.

- Indirect heating can eliminate hotspots in the heating coils of the storage container; indirect heating can be achieved with water, low-pressure or waste steam, or heat transfer oil.
- Bringing one emulsified asphalt into contact with another of a different grade (or with a cutback asphalt) in any storage, transfer, mixing, or application equipment can cause premature coalescence of the asphalt in the system, rendering the emulsified asphalt useless and the equipment inoperable. The recommended procedure to use when placing emulsified asphalts in a storage container is to reduce the volume of the previously stored material to less than 0.5 percent of the total storage volume of the container.

4.0 APPENDICES

4.1 Appendix A

4.1.1 CALIFORNIA

4.1.1.1 RACT for San Bernardino, Fresno and San Francisco Areas. San Bernardino, which is part of the South Coast Air Quality Management District (SCAQMD), follows the RACT presented below.

"Proposed Rule 1108 - Cutback Asphalt

(a) Definitions

For the purpose of this rule, cutback asphalts for paving are defined as Rapid, Medium or Slow Curing grades as defined in Section 93 of the January 1978, State of California Department of Transportation Standard Specifications.

(b) Requirements

Effective April 2, 1980 a person shall not use for paving, road construction, or road maintenance any cutback asphalt which contain more than 0.5 percent by volume organic compounds which evaporate at 260°C (500°F) or less as determined by ASTM Method D 402-- latest revision.

(c) Until December 31, 1981, the provisions of subsection

(b) shall not apply to:

- (1) The use of medium curing asphalt as a penetrating prime coat, or
- (2) The use of medium curing asphalt when the weather forecast of the highest ambient temperature for the 24-hour period following application is below 10°C (50°F).

For the purpose of this subsection, an acceptable weather forecast is one published by the National Weather Service for the immediate vicinity of the asphalt application.

Proposed Rule 1108.1 - Emulsified Asphalt

(a) Definitions

For the purpose of this rule, emulsified asphalt for paving is defined as any asphalt liquified with water containing an emulsifier.

(b) Requirements

Effective January 1, 1982 a person shall not use for paving, road construction, or road maintenance any emulsified asphalt which contains more than 3 percent by volume organic compounds which evaporate at 260°C (500°F) or less as determined by ASTM Method D 244, or such other test method as approved by the Executive Officer."

RACT for the Fresno APCD is presented below.

"1. Definitions

- A. 'Asphalt' means the dark-brown to black cementation material (solid, semi-solid, or liquid in consistency) of which the main constituents are bitumens which occur naturally or as a residue of petroleum refining.
- B. 'Cutback asphalt' means paving grade asphalts liquefied with petroleum distillate and as further defined by American Society for Testing and Materials (ASTM) specifications as follows:
 - Rapid cure type: ASTM D 2028
 - Medium cure type: ASTM D 2027
- C. 'Dust palliative' means any light application of liquefied asphalt (cutback or emulsified asphalt) for the express purpose of controlling loose dust.
- D. 'Emulsified asphalt' means any asphalt liquefied with water containing an emulsifier. The two kinds of emulsions most pertinent are the anionic and cationic types.

- E. 'Penetrating prime coat' means any application of asphalt to an adsorptive surface to penetrate and bind the aggregate surface or promote adhesion between it and the new superimposed construction. Prime coats do not include dust palliatives or tack coats.
- F. 'Road Oils' shall be synonymous with slow cure asphalts.
- G. 'Tack coat' means any application of asphalt applied to an existing surface to provide a bond between new surfacing and existing surface and to eliminate slippage planes where the new and existing surfaces meet.

2. Prohibitions

- A. After July 1, 1979, no person shall cause or allow the use or application of rapid cure cutback asphalt for highway or street paving or maintenance, nor manufacture, sell, or offer for sale cutback asphalt for such use or application.
- B. After July 1, 1980, no person shall cause or allow the use or application of cutback asphalt for highway or street paving or maintenance, nor manufacture, sell, or offer for sale cutback asphalt for such use or application except as specified below:
 - 1) Where the cutback asphalt is to be used solely as a penetrating prime coat;
 - 2) Where the National Weather Service official forecast of the high temperature for the 24-hour period following application is below 50°F (10°C).
 - 3) Where cutback asphalt is required for cold laid surfacing using a graded aggregate or sand.
- C. After January 1, 1982, road oils used for highway or street paving or maintenance applications shall contain no more than 0.5 percent of organic compounds which boil at less than 500°F as determined by ASTM D 402-73.

After January 1, 1985, no person shall cause or allow the use or application of cutback asphalt, or shall cause or allow the use or application of an emulsified asphalt containing petroleum solvents (dilutents) in excess of 3 percent by volume for highway or street paving or maintenance, nor sell, or offer for sale such asphalts for such use or application.

3. Exemptions

- A. The provisions of subsection 2.B. and 2.C. of this Rule do not apply to cutback asphalt sold in the District for shipment and use outside the District."

San Francisco, which is part of the Bay Area Air Quality Management District (BAAQMD), abides by the RACT presented below.

"8-15-100 GENERAL

8-15-101 Description: The purpose of this Rule is to limit the emissions of volatile organic compounds caused by the use of cutback asphalt in paving materials and paving and maintenance operations.

8-15-110 Exemptions, Penetrating Prime Coat: The requirements of Section 8-15-302 shall not apply to the use of cutback asphalt as a penetrating prime coat for aggregate bases prior to paving. This exemption shall end January 1, 1982.

8-15-111 Exemptions, Slow-cure Liquid Asphalt: The requirements of Section 8-15-302 shall not apply to the use of slow-cure liquid asphalt for the manufacture of asphalt/aggregate mixes.

8-15-112 Exemption, Cool Weather: The requirements of Section 8-15-302 shall not apply when the National Weather Service forecasts atmospheric temperature for the 24 hour period following application will be below 10°C (50°F).

8-15-200 DEFINITIONS

8-15-201 Asphalt: The dark brown to black cementitious material (solid or liquid) of which the main constituents are bitumens which occur naturally or as a residue of petroleum refining.

8-15-202 Cutback Asphalt: Any asphalt which has been liquefied by blending with petroleum solvents.

8-15-203 Emulsified Asphalt: Any asphalt liquefied with water containing an emulsifier.

8-15-204 Medium-cure Liquid Asphalt: A cutback asphalt which meets the standard specifications of ASTM Designation D 2027.

8-15-205 Paving Material: A mixture consisting mainly of an asphalt and aggregate.

8-15-206 Paving and Maintenance Operations: All activities involved in the new construction and maintenance of roadways and parking areas.

8-15-207 Penetrating Prime Coat: A low-viscosity liquid asphalt which is applied to an absorbent material in order to prepare the surface for paving.

- 8-15-208 Rapid-cure Liquid Asphalt: A cutback asphalt which meets the standard specifications of ASTM Designation D 2028.
- 8-15-209 Slow-cure Liquid Asphalt (Road Oil): Asphalt which meets the standard specifications of ASTM Designation D 2026, and which shall be further defined as containing no more than 5% by volume of total distillate to 260°C (500°F) as determined by ASTM Distillation Method D402. For purposes of this Regulation, Road Oil and SC Liquid Asphalt shall be synonymous.
- 8-15-300 STANDARDS
- 8-15-301 Rapid-cure Liquid Asphalt: After June 1, 1979, a person shall not use any rapid-cure liquid asphalt in paving material or in paving and maintenance operations.
- 8-15-302 Cutback Asphalt: After March 31, 1980, a person shall not use any cutback asphalt in paving material or in paving and maintenance operations during the months of April through October.
- 8-15-303 Emulsified Asphalt: After January 1, 1982, a person shall not use any emulsified asphalt containing petroleum solvents in excess of 3% by volume in paving material or in paving and maintenance operations."

4.1.1.2 Bituminous-Materials-Use Table for California. CalTrans, two emulsion suppliers, two paving contractors, and three county road departments provided the data used to compile the composite bituminous-materials-use table for California, which is presented in two sections. Section 1 of Table 13 lists responses from CalTrans' Materials Laboratory, the contractors, and the suppliers. Section 2 of Table 13 lists responses from the CalTrans District Office and a county road department in each of the three APCD's studied. The operation exempted from RACT by the APCD's (penetrating prime coat), are underscored.

Table 13

BITUMINOUS-MATERIALS-USE TABLE FOR CALIFORNIA, SECTION 1:

CALTRANS, CONTRACTORS, AND SUPPLIERS^a

Road Construction or Maintenance Operation	Pre-RACT Use ^b			Post-RACT Use (Through 1980)		
	CalTrans (Statewide)	Contractor		CalTrans (Statewide)	Contractor	
		A	B		A	B
Asphalt Concrete						
Cutback	5	5	5	5	5	5
Emulsified	4	5	5	4	5	5
Road-Mixed Asphalt Surfacing						
Cutback	5	5	-	5	-	1
Emulsified	5	5	-	5	-	5
Seal Coat ^c						
Cutback	5	5	5	5	5	5
Emulsified	1	1	5	1	5	1
Fog Seal						
Cutback	5	5	2	5	3	5
Emulsified	1	1	2	1	1	1
Prime Coat						
Cutback	1	1	1	1	1	1
Emulsified	5	3	5	5	3	5
Tack Coat						
Cutback	5	5	2	5	5	5
Emulsified	1	1	2	1	1	1
Patch Material: Immediate Use						
Cutback	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5
Stockpile						
Cutback	1	5	5	1	5	5
Emulsified	5	5	5	5	5	5
Paved Shoulders						
Cutback	5	5	-	5	-	5
Emulsified	5	5	-	5	-	5
Dust Palliative						
Cutback	5	5	-	5	-	5
Emulsified	3	5	-	3	-	5

Table 13, Section 1

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use ^b				Post-RACT Use (Through 1980)			
	CalTrans (Statewide)		Contractor		CalTrans (Statewide)		Contractor	
	A	B	A	B	A	B	A	B
Aggregate Precoat								
Cutback	5		5	-			5	-
Emulsified	5		5	-			5	-
Recycling								
Cutback	5		5	-			5	-
Emulsified	1		5	-			5	-

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

bDate varies among the three areas evaluated (see Appendix A, Section 4.1.1.1).

cSeal coat includes rock and chip seal applications.

dIncluded under fog seal.

Table 13

BITUMINOUS-MATERIALS-USE TABLE FOR CALIFORNIA, SECTION 2:

CALTRANS DISTRICTS AND COUNTIES^a

	Pre-RACT Use ^b				Post-RACT Use (Through 1980)			
	Bay Area AQMD CalTrans Dist. #4	County	Fresno County CalTrans Dist. #6	County	Bay Area AQMD CalTrans Dist. #4	Fresno County CalTrans Dist. #6	South Coast AQMD CalTrans Dist. #8	County
Road Construction or Maintenance Operation	5	5	2	5	5	2	1	2
Asphalt Concrete	5	5	5	5	5	2	5	5
Cutback Emulsified	-	-	1	5	-	1	-	1
Road-Mixed Asphalt Surfacing	5	5	5	5	5	3	-	5
Cutback Emulsified Seal Coat	5	5	2	5	5	5	5	5
Cutback Emulsified	2	1	1	1	2	1	1	1
Fog Seal	5	5	5	5	5	5	5	5
Cutback Emulsified	5	5	1	1	5	1	1	1
Prime Coat	5	5	5	5	5	5	5	5
Cutback Emulsified	1	5	5	5	5	5	5	5
Tack Coat	1	5	1	5	1	1	1	5
Cutback Emulsified	5	5	5	3	5	5	5	5
Patch Material: Immediate Use	1	1	1	1	1	1	1	1
Cutback Emulsified	5	5	2	5	5	2	1	1
Stockpile	5	5	3	5	5	3	5	5
Cutback Emulsified	1	5	2	5	1	2	1	1
Paved Shoulders	5	5	5	5	5	5	5	5
Cutback Emulsified	2	5	2	5	5	2	1	2
Dust Palliative	5	5	1	5	2	3	5	5
Cutback Emulsified	5	5	5	5	5	5	5	5
Cutback Emulsified	1	5	2	5	1	2	1	5

Table 13, Section 2
(Continued)

	Pre-RACT Use ^b				Post-RACT Use (Through 1980)			
	Bay Area AQMD	Fresno County APCD	South Coast AQMD		Bay Area AQMD	Fresno County APCD	South Coast AQMD	
	CalTrans Dist. #4	County Dist. #6	CalTrans Dist. #8	County	CalTrans Dist. #4	County Dist. #6	CalTrans Dist. #8	County
Road Construction or Maintenance Operation	-	5	-	5	-	-	-	-
Aggregate Precoat	-	5	-	5	-	-	-	-
Cutback	-	5	-	5	-	-	-	-
Emulsified	-	5	-	5	-	-	-	-
Recycling	-	2	-	5	-	-	-	-
Cutback	-	2	-	5	-	-	-	-
Emulsified	-	2	-	5	-	-	-	-

where 1 = generally used
2 = sometimes used
3 = used on a selected or trial basis
4 = currently not used but in research and development stage
5 = never used.

mate varies among the three areas evaluated (see Appendix A, Section 4.1.1.1).
cSeal coat includes rock and chip seal work.

4.1.1.3 California Road Construction and Maintenance Operations.
Standard Specifications, State of California Business and Transportation
Agency, Department of Transportation, January, 1978 edition was used as a
reference to prepare California's bituminous-materials-use table. Twelve
categories of road construction and maintenance operations were evaluated.
These categories and recommended bituminous materials are listed below. The
operation exempt from RACT is underscored.

<u>Road Construction or</u> <u>Maintenance Operation</u>	<u>Cutback</u> <u>Asphalts</u>	<u>Emulsified</u> <u>Asphalts</u>
Asphalt Concrete	a	
Road-Mixed Asphalt Surfacing	a	
Seal Coat	a	b
Fog Seal		SS, CSSC
<u>Prime Coat</u>	a	b
<u>Tack Coat</u>	d	d
Patch Material:		
Immediate Use	d	d
Stockpile	d	d
Paved Shoulders	d	d
Dust Palliative		SS-1
Aggregate Precoat		
Recycling	d	d

^aType and grade to be designated in contract. A list of acceptable cutback
asphalts is found in Section 93 of the reference.

^bType and grade to be designated in contract. A list of acceptable emulsi-
fied asphalts is found in Section 94 of the reference.

^cUnless otherwise specified in contract.

^dCalifornia does not currently have specifications for these materials.

4.1.1.4 Cutback and Emulsified Asphalt Suppliers Who Serve Cali-
fornia. The Asphalt Institute and CalTrans have provided the names and
locations of cutback and emulsified asphalt suppliers who serve California.
The companies and the products they sell are listed below.

<u>Company</u>	<u>Cutback Asphalt</u>	<u>Emulsified Asphalt</u>
Newhall Refinery Newhall, CA	X	X
Chevron USA, Inc.: Bakersfield, CA	X	X
Oakland, CA	X	X
Oildale, CA		X
Witco Chemical Co. Golden Bear Div. Bakersfield, CA	(	X
Emulsified Asphalts, Inc. Fontana, CA		X
Burris Oil and Chemical Co.: Fresno, CA		X
Long Beach, CA		X
Edgington Oil Co. Long Beach, CA	X	X
Shell Oil Co. Martinez, CA	X	X
Douglas Oil Co.: Paramount, CA	X	X
Santa Maria, CA	X	X
Elk Grove, CA	X	X
Granite Rock Co.: Redwood City, CA		X
San Jose, CA		X
Santa Cruz, CA		X
Union Oil Co. Rodeo, CA	X	X
Sim J. Harris Co. San Diego, CA		X
Rebel Oil Co. Redland, CA		X
Reed and Graham, Inc. San Jose, CA		X

4.1.2 COLORADO

4.1.2.1 Colorado Road Construction and Maintenance Operations.

Colorado's Standard Specifications for Road and Bridge Construction, 1976 edition, was used as the reference for road construction and maintenance operations. Eleven road construction and maintenance categories, which are listed below, were selected for evaluation in Colorado's bituminous-materials-use table. The exempt road construction and maintenance operations for the 1980 paving season are underscored.

Road Mix Bituminous Base Course
Seal Coat
Fog Seal
Prime Coat
Tack Coat
Paved Shoulders

Patch Material:
Immediate Use
Stockpile
Dust Palliative
Recycling
Aggregate Precoat

Colorado conforms to the American Association of State Highway and Transportation Officials (AASHTO) Designation M 81 for RC cutback asphalts, M 82 for MC cutback asphalts, M 140 for emulsified (anionic) asphalts, and M 208 for cationic emulsified asphalts. AASHTO Designation M 141 for SC cutback asphalts was deleted in AASHTO's 1978 specifications; however, specifications for SC cutback asphalts can be found in ASTM D 2026-77, Annual Book of ASTM Standards, 1980.

4.1.2.2 Cutback and Emulsified Asphalt Suppliers Who Serve Colorado.

The following is a list of CDH's 1980 cutback and emulsified asphalt suppliers who provide material for highway maintenance work.

<u>Company</u>	<u>Refinery Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Asphalt Supply and Service 4301 East 40th Avenue Denver, CO 80216	Casper, WY Denver, CO	X (RC)	X
Colorado Bitumuls, Inc. 5301 No. Bannock Denver, CO 80216	Denver, CO		X
Deal Petroleum Co. P.O. Box 7038 Tulsa, OK 74105	Arkansas City, KS	X (RC, MC)	
Husky Oil Co. P.O. Box 380 Cody, WY 82414	Cody, WY Cheyenne, WY	X (RC, MC)	
Penelizer Corp. 5701 Dexter Street Commerce City, CO 80022	Commerce City, CO		X
Phillips Petroleum Co. P.O. Box 239 Salt Lake City, UT 84110	Wood Cross, UT		X
Riffe Petroleum Co. 1111 Philtower Building Tulsa, OK 74103	Sheerin, TX	X (RC, MC)	
Sinclair Marketing P.O. Box 1677 Englewood, CO 80110	Sinclair, WY	X (MC)	

There are two other emulsion suppliers located in Colorado according to a 1979 update of Emulsion Plants in the United States, Canada, and Mexico, compiled by the Asphalt Emulsion Manufacturers Association (AEMA), 1977.

They include:

Colorado Bitumuls, Inc.
642 S. Second Street
Grand Junction, CO 81501

Continental Oil Co.
5801 Brighton Boulevard
Denver, CO 80216

4.1.3 INDIANA

4.1.3.1 Bituminous-Materials-Use Table for Indiana. ISHC, two county highway departments (one urban and one rural), and two paving contractors provided data used to compile the composite bituminous-materials-use table for Indiana which is given in two sections. Section 1 of Table 14 lists responses from ISHC and the two counties; section 2 of Table 14 lists responses from the two paving contractors. The exempt road construction and maintenance operations specified in Indiana's RACT are underscored; these include the prime coat and cold mix bituminous pavement (stockpile) categories.

4.1.3.2 Indiana Road Construction and Maintenance Operations. Indiana State Highway Standard Specifications, 1978 edition was used as the reference for selecting the road construction and maintenance operations which permit the use of either cutback or emulsified asphalts. Indiana specifications for cutback and emulsified asphalts can be found in Section 902 of the reference. Sixteen road construction and maintenance categories were evaluated for Indiana; these categories and their recommended bituminous materials (if specified) are listed following Table 14. The categories which RACT exempts are underscored.

Table 14

BITUMINOUS-MATERIALS-USE TABLE FOR INDIANA, SECTION 1: ISHC & COUNTIES^a

	Pre-RACT Use Prior to January 20, 1980			Post-RACT Use (Through 1980)					
	County		ISHC	Regulated Season from April 1 to Oct. 31		ISHCb	Nonregulated Season from Nov. 1 to May 31		County
	Urban	Rural		Urban	Rural		Urban	Rural	
Road Construction or Maintenance Operation									
Plant Mix Bituminous Base Course									
Cutback	5	1		5	-	-	5	5	5
Emulsified	2	-		5	2	-	5	5	5
Road Mix Bituminous Base Course									
Cutback	2	1		5	-	-	5	5	5
Emulsified	1	-		5	2	-	5	5	5
Bituminous Stabilized Subbase Type I									
Cutback	5	5		5	5	-	5	5	5
Emulsified	1	5		5	5	-	5	5	5
Type II									
Cutback	5	5		5	5	-	5	5	5
Emulsified	2	5		2	5	-	-	-	5
Bituminous Coated Aggregate Pavement									
Cutback	5	1		5	5	-	5	5	5
Emulsified	1	-		5	1	-	5	5	5
Road Mix Bituminous Pavement									
Cutback	3	5		5	5	-	5	5	5
Emulsified	1	5		5	5	-	5	5	5
Cold Mix Bituminous Pavement ^c									
Immediate Use									
Cutback	5	5		5	5	-	5	5	5
Emulsified	1	5		5	5	-	5	5	5
Stockpile									
Cutback	5	5		5	5	-	5	5	5
Emulsified	1	5		5	5	-	5	5	5
Bituminous Seal Coat									
Cutback	2	1		1	5	-	5	5	5
Emulsified	1	5		3	1	-	-	-	5

Table 14, Section 1

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use Prior to January 20, 1980			Post-RACT Use (Through 1980)					
	ISHC	County		Regulated Season from April 1 to Oct. 31		Nonregulated Season from Nov. 1 to May 31			
		Urban	Rural	ISHCb	Urban	ISHCb	Urban	ISHCb	Rural
Fog Seal									
Cutback	5	5	5	-	5	-	5	-	5
Emulsified	3	5	5	-	5	-	5	-	5
Bituminous Prime Coat									
Cutback	2	1	1	-	-	-	-	-	5
Emulsified	1	5	5	-	-	-	-	-	5
Bituminous Tack Coat									
Cutback	2	1	1	-	-	-	-	-	5
Emulsified	1	3	5	-	-	-	-	-	5
Paved Shoulders									
Cutback	5	5	5	-	5	-	5	-	5
Emulsified	2	5	5	-	5	-	5	-	5
Dust Palliative									
Cutback	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5	5
Aggregate Precoat									
Cutback	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5	5
Recycling									
Cutback	5	5	5	-	5	-	5	-	5
Emulsified	3	5	5	-	5	-	5	-	5

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

bThe ISHC commented, "We have not filled in the sections of the questionnaire dealing with expected usage. We are now using a very minimal amount of cutback asphalt."

cCold mix bituminous pavement mixes are used as bituminous patch material.

Table 14

BITUMINOUS-MATERIALS-USE TABLE FOR INDIANA, SECTION 2: CONTRACTORS^a

Road Construction or Maintenance Operation	Pre-RACT Use Prior to January 20, 1980		Post-RACT Use (Through 1980)			
	Contractor		Regulated Season from April 1 to Oct. 31		Nonregulated Season from Nov. 1 to May 31	
	A	B	A	B	A	B
Plant Mix Bituminous Base Course						
Cutback	2	5				
Emulsified	2	1	5	5	2	5
Road Mix Bituminous Base Course			2	1	2	5
Cutback	1	2				
Emulsified	2	2	1	5	5	5
Bituminous Stabilized Subbase			2	1	5	5
Type I						
Cutback	5	5				
Emulsified	1	1	5	5	5	5
Type II			1	1	5	5
Cutback	5	5				
Emulsified	2	5	5	5	5	5
Bituminous Coated Aggregate Pavement			1	5	5	5
Cutback	5	5				
Emulsified	1	1	5	5	5	5
Road Mix Bituminous Pavement			1	1	1	1
Cutback	1	2				
Emulsified	2	2	1	5	5	5
Cold Mix Bituminous Pavement ^b			2	1	5	5
Immediate Use						
Cutback	5	2				
Emulsified	1	2	5	2	5	2
Stockpile			1	1	1	1
Cutback	5	2				
Emulsified	1	1	5	2	5	2
Bituminous Seal Coat			1	1	1	1
Cutback	2	2				
Emulsified	2	1	5	5	5	5
			1	1	5	5

Table 14, Section 2
(Continued)

	Pre-RACT Use		Post-RACT Use (Through 1980)			
	Prior to January 20, 1980		Regulated Season from April 1 to Oct. 31		Nonregulated Season from Nov. 1 to May 31	
	Contractor A	Contractor B	Contractor A	Contractor B	Contractor A	Contractor B
Road Construction or Maintenance Operation						
Fog Seal						
Cutback	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1
Bituminous Prime Coat						
Cutback	1	1	1	1	5	5
Emulsified	5	2	5	2	5	5
Bituminous Tack Coat						
Cutback	5	5	5	5	5	5
Emulsified	1	1	1	1	5	5
Bituminous Shoulders						
Cutback	5	5	5	5	5	5
Emulsified	2	1	2	1	5	5
Dust Palliative						
Cutback	1	1	1	1	5	5
Emulsified	5	3	5	4	5	5
Aggregate Precoat						
Cutback	2	2	5	2	5	5
Emulsified	2	2	1	2	5	5
Recycling						
Cutback	5	5	5	5	5	5
Emulsified	5	1	5	1	5	5

^aWhere 1 = generally used
2 = sometimes used
3 = used on a selected or trial basis
4 = currently not used but in research and development stage
5 = never used.

^bCold mix bituminous pavement mixes are used as bituminous patch material.

	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Plant Mix Bituminous Base Course ^a		
Road Mix Bituminous Base Course ^b		
Bituminous Stabilized Subbase		
Type I		AE-150
Type II		AE-60
Bituminous Coated Aggregate Pavement		AE-60,90
Hot Asphalt Emulsion Pavement		AE-60
Road-Mix Bituminous Pavement	RC-800	AE-90,150
	RCA-800	
Cold Mixed Bituminous Pavement		
Immediate Use		AE-90,150
Stockpile		AE-150
Bituminous Seal Coat	RC-800,3000	RS-2,
		AE-90, 150
Fog Seal ^c		
Bituminous Prime Coat	MC-70	AE-P
Bituminous Tack Coat	RC-70	AE-T
Paved Shoulders ^a		
Recycling ^c		
Dust Palliative ^c		
Aggregate Precoat ^c		

^aSee Hot Asphalt Emulsion Pavement, Bituminous Coated Aggregate Pavement, and Cold Mix Bituminous Pavement for material recommendations.

^bSee Road Mix Bituminous Pavement for material recommendations.

^cISHC does not currently have specifications for these operations.

4.1.3.3 Cutback and Emulsified Asphalt Suppliers Who Serve Indiana.

The ISHC Division of Materials and Tests prepares a "green sheet" of bituminous materials which may be used as soon as they arrive at their destination, ("Immediate Usage List of Bituminous Materials"). The following grades of cutback and emulsified asphalts with their source and location have been copied from the January 1980 listing.

<u>Company</u>	<u>Plant Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Ashland Refining Company	Louisville, KY	RC-70,800 MC-70	
Asphalt Material and Construction Inc.	Indiannapolis, IN	MC-70	RS-2 AE-60,90,150,300
Bituminous Materials Co.	Warsaw, IN		RS-2 AE-60,90,150,300,P
Chevron U.S.A. Inc. Asphalt Division	Louisville, KY	MC-70	RS-2 AE-60,150
Chevron U.S.A. Inc.	North Bend, OH	MC-70	RS-2 AE-60
Emulsified Asphalt	Chicago, IL		AE-150
Emulsions, Incorporated Division Bituminous Materials Co.	Lawrenceville, IL		RS-2 AE-60,90,150, 300,P
Energy Cooperative, Inc. (formerly C.F. Petroleum)	East Chicago, IN	RC-70,800, 3000 MC-70	
Exxon	Louisville, KY		AE-60,P
Fauber Construction Co.	Lafayette, IN		RS-2 AE-60,90,150,300,P
Greenland, Incorporated Division Ashland Oil, Inc.	North Vernon, IN		RS-2 AE-60,90,150,P
Magaw Construction Inc.	Richmond, IN	MC-70	RS-2
Marathon Oil Co. (Trumbull Asphalt)	Detroit, MI		AE-60,90,150,300,P
Seneca Petroleum Corp.	Lemont, IL Michigan City, IN	RC-70	RS-2 AE-60,90,150
Shell Oil Co.	Cincinnati, OH	RC-70 MC-70	

<u>Company</u>	<u>Plant Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Standard Oil Division	Whiting, IN	RC-800 RC-70	
Texaco, Inc.	Lawrenceville, IL	RC-70,800 MC-70	
Walsh and Kelly Div. Bituminous Materials Co.	Griffith, IN		RS-2 AE-60,90,150,300,P

^aThis material requires a job sample.

4.1.4 MISSOURI

4.1.4.1 Missouri Road Construction and Maintenance Operations.

Missouri Standard Specifications for Highway Construction, 1977 edition (amended January 1980) was used to prepare the bituminous-materials-use table for Missouri. Twelve categories of road construction and maintenance operations were examined. These categories and their recommended bituminous materials are given below. The categories to be exempted from RACT are underscored.

	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Plant Mix Bituminous Pavement ^a	MC ^b	
Road Mix Bituminous Pavement	RC-3000, MC-3000	RS-1, RS-2, CRS-1,
Seal Coat		CRS-2
Fog Seal ^c	RC, MC ^d	d
Prime Coat	RC-70; MC-30, 70	SS-1, SS-1h, CSS-1,
Tack Coat		CSS-1h

Cutback Asphalts Emulsified Asphalts

Patch Material:^C
 Immediate Use
 Stockpile
 Paved Shoulders^C
 Dust Palliative^C
 Aggregate Precoat^C
 Recycling^C

^aUntil November 1979, both asphalt cements and cutback asphalts were specified. After that time, cutback asphalts were deleted. This category is included because MHTD foresees an amendment to the plant mix bituminous pavement specifications which would allow emulsified asphalt use. MHTD expects increased use of emulsified asphalts in plant mix bituminous surface leveling, but this category is excluded from this study since its specification has never called for the use of cutback or emulsified asphalts.

^bThe grade is to be specified in the contract and is to be one of the following: MC-30, 70, 250, 800, or 3000.

^cMHTD does not currently have specifications for these operations.

^dThe type and grade are to be specified in the contract (see Section 10.15 of the reference).

MHTD's specifications for emulsified asphalts include those in AASHTO M 140 and M 208 as well as three other items -- CMS-2 (modified), with which has a higher penetration than CMS-2, and EA-150, and EA-300 (high-float medium-set emulsified asphalt).

4.1.4.2 Cutback and Emulsified Asphalt Suppliers Who Serve Missouri.

MHTD maintains a list of cutback and emulsified asphalt suppliers who bid on state jobs. A copy of this list showing the companies, their locations, and the products they offer is presented below.

<u>Company and Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Allied Materials Corp. Stroud, OK 74079	X	X

<u>Company and Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Amoco Oil Co. Sugar Creek, MO 65054	X	
Amoco Oil Co. Wood River, IL 62095	X	
Bitucote Products Co. Springdale, AR 72764		X
Bitucote Products Co. Des Moines, IA 50309		X
Bitucote Products Co. St. Louis, MO 63139		X
Chevron Asphalt Co. St. Louis, MO 63139		X
Delta Asphalt, Inc. P.O. Box 125 New Madrid, MO 63869		X
Delta Refining Co. Memphis, TN 38109	X	
Energy Sales, Inc. Cabool, MO 65689	X	
Energy Sales, Inc. Springfield, MO 65801	X	
Kansas Emulsions, Inc. El Dorado, KS 67042		X
Kaw Industries, Inc. P.O. Box 30 Ponca City, OK 74601	X	
Kirksville Emulsified Asphalts, Inc. Kirksville, MO 63501		X
Louis Marsch, Inc. Morrisonville, IL 62546		X
Louis Marsch, Inc. Troy, MO 63379		X
Meredosia Terminals, Inc. (Riffe Petroleum Co.) Meredosia, IL 62665		X

<u>Company and Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Missouri Emulsions Inc. Box 1583 Sedalia, MO 65301		X
Mobil Oil Corp. Augusta, KS 67010	X	
NuWay Emulsions, Inc. Springfield, MO 65801		X
Pester Refining Co. El Dorado, KS 67042	X	
Phillips Petroleum Co. (Union Asphalt and Road Oils) Kansas City, KS 66106	X	X
Producers Group, Inc. Chanute, KS 66720	X	
Road Emulsions Eldon, Inc. Eldon, MO 65026		X
Road Emulsions Pittsburg, Inc. Pittsburg, KS 66762		X
Shell Oil Co. Wood River, IL 62095	X	X
Southern States Asphalt Co. Cameron, MO 64429		X
Southern States Asphalt Co. Moberly, MO 65270		X
Sun Oil Co. Tulsa, OK 74119	X	
Texaco, Inc. Tulsa, OK 74119	X	

<u>Company and Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Total Petroleum, Inc. (Apco Refinery) Arkansas City, KS 67005	X	
Vance Bros., Inc. Kansas City, MO 64130		X
Vickers Petroleum Corp. (Riffe Petroleum Co.) Ardmore, OK 73401	X	

4.1.5 PENNSYLVANIA

4.1.5.1 Bituminous-Materials-Use Table for Pennsylvania. PennDOT, the Asphalt Institute, the Bureau of Municipal Services, three paving contractors, and two emulsified asphalt suppliers provided data used to compile the composite bituminous-materials-use table for Pennsylvania which is presented in two sections. Section 1 of Table 15 lists responses from PennDOT, the Asphalt Institute, and the Bureau of Municipal Services; Section 2 of Table 15 lists responses from the contractors and suppliers. The operations which are currently exempt under Pennsylvania's RACT are underscored; these include the prime coat, tack coat, stockpile patch material, dust palliative, and aggregate precoat categories.

4.1.5.2 Pennsylvania Road Construction and Maintenance Operations. Form 408 Specification, 1976 edition (with addenda) and PennDOT's Bulletin #25, "Specifications for Bituminous Materials", 1979 edition were used as references to prepare Pennsylvania's bituminous-materials-use table. Sixteen categories in road construction or maintenance were evaluated; these and other

Table 15

BITUMINOUS-MATERIALS-USE TABLE FOR PENNSYLVANIA, SECTION 1:
AI, PENNDOT, AND BUREAU OF MUNICIPAL SERVICES^a

Road Construction or Maintenance Operation	Post-RACT Use (Through 1980)					
	Pre-RACT Use			Regulated Season		
	Prior to May 1, 1980		Bur. of Mun. Ser.	from May 1 to October 31		Nonregulated Season from November 1 to April 30
	AI and PennDOT	Bur. of Mun. Ser.		AI and PennDOT	Bur. of Mun. Ser.	
Aggregate-Bituminous Base Course						
Cutback	2	5		5	5	1b
Emulsified	2	1		1	1	2b
Soil-Bituminous Base Course						
Cutback	2	5		5	5	1b
Emulsified	2	2		1	1	2b
Bituminous Surface Course FB-2						
Cutback	2	1		5	5	1b
Emulsified	2	2		1	1	2b
Bituminous Surface Course FB-1						
Cutback	2	1		5	5	1b
Emulsified	2	2		1	1	2b
Bituminous Surface Course CP-2						
Cutback	2	1		5	5	1b
Emulsified	2	2		1	1	2b
Bituminous Surface Course DP-1						
Cutback	2	2		5	5	1b
Emulsified	2	2		1	1	2b
Bituminous Seal Coat						
Cutback	1	1		5	5	1b
Emulsified	1	2		1	1	2b
Bituminous Surface Treatment						
Cutback	1	1		5	5	1b
Emulsified	1	2		1	1	2b
Fog Seal						
Cutback	-	3		-	5	-
Emulsified	-	1		-	1	-
Bituminous Prime Coat						
Cutback	1	1		1	5	1
Emulsified	5	2		5	1	5

Table 15, Section 1

(Continued)

	Pre-RACT Use				Post-RACT Use (Through 1980)			
	Prior to May 1, 1980		Regulated Season		Regulated Season		Nonregulated Season	
	AI and PennDOT	Bur. of Mun. Ser.	AI and PennDOT	Bur. of Mun. Ser.	AI and PennDOT	Bur. of Mun. Ser.	AI and PennDOT	Bur. of Mun. Ser.
Road Construction or Maintenance Operation								
Bituminous Tack Coat								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	2b	1
Bituminous Stockpile Patch Material								
Cutback	1	1	1	5	1	5	1	1
Emulsified	2	2	2	1	2	1	2b	2
Paved Shoulders								
Cutback	1	5	5	5	5	5	1	5
Emulsified	1	5	1	5	1	5	2b	5
Dust Palliative								
Cutback	1	1	1	5	1	5	1	1
Emulsified	5	2	5	1	5	1	5	2
Aggregate Precoat								
Cutback	1	1	1	5	1	5	1	1
Emulsified	3	2	3	1	3	1	3	2
Recycling								
Cutback	5	5	5	5	5	5	4b	5
Emulsified	4	2	4	2	4	1	2b	2

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

bSpecifications on weather will limit the use of these materials.

Table 15

BITUMINOUS-MATERIALS-USE TABLE FOR PENNSYLVANIA
SECTION 2: CONTRACTORS AND SUPPLIERS^a

Road Construction or Maintenance Operation	Pre-RACT Use						Post-RACT Use (Through 1980)					
	Prior to May 1, 1980			Regulated Season from May 1 to October 31			Regulated Season from May 1 to October 31			Nonregulated Season from November 1 to April 30		
	Contractor		Supplier	Contractor		Supplier	Contractor		Supplier	Contractor		Supplier
	A	B	C	A	B	C	A	B	C	A	B	C
Aggregate-Bituminous Base Course												
Cutback	5	-	2	2	-	-	5	-	5	5	-	2
Emulsified	1	-	1 ^b	2	-	-	1	-	1	5	-	2 ^b
Soil-Bituminous Base Course												
Cutback	5	-	1	2	4	4	5	-	5	5	-	1 ^c
Emulsified	5	-	4 ^b	2	4	4	5	-	4 ^b	5	-	4 ^{b,c}
Bituminous Surface Course FB-2												
Cutback	1	-	- ^d	3	1	1	5	-	- ^d	5	-	- ^d
Emulsified	5	-	- ^d	5	5	5	2	-	- ^d	5	-	- ^d
Bituminous Surface Course FB-1												
Cutback	5	-	1	1	1	1	5	-	5	5	-	1
Emulsified	1	-	1 ^b	2	5	5	1	-	1	5	-	1 ^b
Bituminous Surface Course CP-2												
Cutback	5	2	2	1	1	1	5	-	5	5	1	1
Emulsified	5	2	2 ^b	2	5	5	5	1	1	5	-	1 ^b
Bituminous Surface Course DP-1												
Cutback	5	-	5	1	1	1	5	-	5	5	-	2
Emulsified	5	-	5	2	5	5	5	-	2	5	-	2 ^b
Bituminous Seal Coat												
Cutback	2	2	1	2	1	1	5	-	5	2	1	1
Emulsified	2	2	1 ^b	2	5	5	1	1	1	2	-	1 ^b
Bituminous Surface Treatment												
Cutback	2	2	1	2	1	1	5	-	5	2	1	1
Emulsified	2	2	1 ^b	2	5	5	1	1	1	2	-	1 ^b
Fog Seal												
Cutback	5	-	-	2	5	5	5	-	-	5	-	-
Emulsified	5	-	1	2	5	5	5	-	1	5	-	-
Bituminous Prime Coat												
Cutback	2	1	1	1	1	1	3	1	1	5	5	1
Emulsified	1	-	4	5	5	5	2	-	4	2	-	4

Table 15, Section 2

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use						Post-RACT Use (Through 1980)					
	Prior to May 1, 1980			Regulated Season from May 1 to October 31			Regulated Season from November 1 to April 30			Nonregulated Season from November 1 to April 30		
	Contractor			Contractor			Contractor			Contractor		
	A	B	C	A	B	C	A	B	C	A	B	C
Bituminous Tack Coat												
Cutback	2	1	5	3	1		5	-	5	5		
Emulsified	1	2	1	1	5		1	-	1	1		
Bituminous Stockpile Patch Material												
Cutback	2	1	1	5	1		5	1	1	5		
Emulsified	2	1	1	1	3		1	-	1	3		
Paved Shoulders												
Cutback	5	2	-e	2	2		5	-	-e	5		
Emulsified	1	2	-e	2	5		1	1	-e	1		
Dust Palliative												
Cutback	-	-	1	-	-		-	-	1	-		
Emulsified	-	-	4	-	-		-	-	4	-		
Aggregate Precoat												
Cutback	-	-	1	-	-		-	-	1	-		
Emulsified	-	-	3	-	-		-	-	3	-		
Recycling												
Cutback	-	-	-f	3	4		5	-	-f	5		
Emulsified	-	-	4	3	4		5	-	4	1		

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

bSpecifications on weather will limit the use of these materials.

cThese materials are used as a protective curing coat.

dFB-1 is normally used.

eThis category is an extension of base and surface course construction.

fRecycling is currently in the research and development stage, with asphalt cements and emulsions being primarily used.

categories specified by PennDOT and their recommended bituminous materials are shown below. The categories currently exempt by RACT are underscored.

	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Aggregate-Bituminous Base Course	RC-200,800 MC-250,800	E-1,4,5,6 RCE-250 ^a
Aggregate-Cement Base Course	MC-30,70	E-1
Aggregate-Lime-Pozzolan Base Course	MC-30,70	E-1
Soil Bituminous Base Course	MC-250,800	E-1,4,5,6 RCE-250
Soil-Cement Base Course	MC-30,70	E-1
Soil-Lime-Pozzolan Base Course	MC-30,70	E-1
Bituminous Surface Course FB-2	RC-250,800 NRC-250,800 ^b	E-4,5,6,11 RCE-250,800
Bituminous Surface Course FB-1	RC-250,800 NRC-250,800	E-4,5,6,11 RCE-250,800
Bituminous Surface Course CP-2	RC-250,800 NRC-250,800	E-4,5,6,11 RCE-250,800
Bituminous Surface Course DP-1	RC-250,800	E-2,3
Bituminous Seal Coat	RC-250,800	E-2,3 RCE-250,800
Bituminous Surface Treatment	RC-250,800	E-2,3 RCE-250,800
Fog Seal ^c		
Bituminous Prime Coat	MC-30,70	
Bituminous Tack Coat		E-1
<u>Bituminous Stockpile Patch Material</u>	MC-250,400E,800	E-10,12 ME-250,800 ^d E-2,3,6
Paved Shoulders ^e		
Dust Palliative	MC-30,70	
Aggregate Precoat	MC-30,70	
Recycling ^c		

^aRCE is an emulsified cutback asphalt.

^bNRC is a cutback native asphalt.

^cPennDOT does not currently have specifications for these operations.

^dME is an emulsified cutback asphalt.

^ePennsylvania lists seven types of paved shoulder work. For the bituminous materials-use table, paved shoulder work in general was evaluated.

4.1.5.3 Cutback and Emulsified Asphalt Suppliers Who Serve Pennsylvania. Section 401.2(a) of Pennsylvania's Bulletin #15, "Tentative List of Commercial Producers of Approved Construction Materials," Publication 35, July, 1979 edition lists 36 companies who supply Pennsylvania with cutback or emulsified asphalts. The companies, plant location, and the type of bituminous material which they supply are listed below:

<u>Company</u>	<u>Plant Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Allegheny Bituminous Co. Box 55 Belmont, NY 14813	Belmont, NY		X
Allied Emulsions, Inc. 505 Como Park Boulevard Buffalo, NY 14225	Buffalo, NY Clearfield, PA		X
Amoco Oil Co. 200 E. Randolph Drive Chicago, IL 60601	3901 Asiatic Avenue Baltimore, MD	X	
Ashland Oil Co. Box 148 Floreffe, PA	Floreffe, PA	X	
Ashland Oil, Inc. P.O. Box 391 Ashland, KY 41101	Ashland, KY	X	
Atlantic-Richfield Co. Products Division 2700 Passyunk Avenue Philadelphia, PA 19145	3144 Passyunk Avenue Philadelphia, PA Three River, NY Cockpit, VA	X X	 X
Bituminous Emulsion Co. P.O. Box 2799 Baltimore, MD 21225	Zinns Quarry Road York, PA		X
Bituminous Emulsion of Northumberland, PA, Inc. P.O. Box 2799 Baltimore, MD 21225	Northumberland, PA	X	X

<u>Company</u>	<u>Plant Location</u>	<u>Cuthack Asphalts</u>	<u>Emulsified Asphalts</u>
Bituminous Emulsion Co. P.O. Box 768 Warren, PA 16365	Warren, PA		X
Bituminous Emulsion Co. Windber, PA 15963	Windber, PA		X
Boswell Oil Company Box 35 Dravosburg, PA 15034	Dravosburg, PA	X	
Celetex Corporation Allied Chemical Corp. 36th & Grays Ferry Road Philadelphia, PA 19146	Philadelphia, PA	X	
Central Asphalt, Inc. Third Street Watkins Glen, NY 14891	Watkins Glen, NY		X
Central Oil Asphalt 100 Darrow Road Akron, OH 44305	Akron, OH Findlay, OH		X X
Chevron USA, Inc. P.O. Box 1955 Baltimore, MD	Baltimore, MD	X	X
Chevron USA, Inc. Box 232 Lyons, NY 14489	Cole Road Lyons, NY	X	X
Chevron USA, Inc. 1200 State Street Perth Amboy, NJ 08862	Perth Amboy, NJ	X	X
Chevron USA, Inc. 13 Mellon Street Springdale, PA 15144	Springdale, PA	X	X
Cortland Asphalt Products Corporation Lorings Crossing RD #1 Cortland, NY 13045	Cortland, NY		X
Dosh-King Emulsions, Inc. 16 Troyhills Road, off Rte. 10W Whippany, NJ 07981	Whippany, NJ		X

<u>Company</u>	<u>Plant Location</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Emulsion Products Co. 1100 Nanticoke Avenue P.O. Box 731 Seaford, DE 19973	Seaford, DE		X
Hammaker Emulsions, Inc. P.O. Box 2855 Harrisburg, PA 17105	Siloam Road Chambersburg, PA		X
Koppers Company, Inc. Organic Materials Division Box 418 Folansbee, WV 26037	Folansbee, WV		X
Mobil Oil Corp. 635 Elk Street Buffalo, NY 14210	Buffalo, NY	X	
Neville Chemical Co. Neville Island, PA 15225	Neville Island, PA	X	
Russell Standard Corp. Bridgeville, PA 15017	Mercer, PA		X
Solar Compounds 1201 W. Blancke Street Linden, NJ 07036	Linden, NJ	X	
M.J. Stavola Industries, Inc. P.O. Box 419 Kingston, NJ 08528	Mt. Holly, NJ		X
The Bituminous Emulsion Co. P.O. Box 2799 Baltimore, MD 21225	3901 Asiatic Avenue Baltimore, MD		X
Valley Emulsion Co. Box 148 Floreffe, PA 15039	Floreffe, PA		X
West Bank Oil, Inc. P.O. Box 638 Pennsauken, NJ 08110	Paulsboro, NJ Pettys Island, NJ Pequest, NJ		X X X
Windsor Service Co. P.O. Box 3206 Hampden Station Reading, PA 19604	3847 Pottsville Pike Tuckerton	X	X

4.1.5.4 Miscellaneous Control Guidelines. In order to offset anticipated emissions from a Volkswagen Rabbit Plant in New Stanton, Pennsylvania, control guidelines effective July 1, 1977 were established for PennDOT's use of cutback and emulsified asphalts.

These guidelines are copied below as they appear in the Environmental Reporter (125.4119), published by the Bureau of National Affairs, Inc., Washington, D.C.

"§52.2054 Control of asphalt paving material.

[42 FR 54416, October 6, 1977]

(a) Notwithstanding any provisions to the contrary in the Pennsylvania Implementation Plan, the Pennsylvania Department of Transportation shall restrict the annual usage of asphalts to the limits listed below in the following sixteen county area of Pennsylvania: Allegheny, Armstrong, Beaver, Butler, Cambria, Clarion, Fayette, Green, Indiana, Jefferson, Lawrence, Mercer, Somerset, Venango, Washington, and Westmoreland Counties:

(1) No more than twenty percent of the total amount of liquid bituminous asphalt paving material used shall be cutback asphalt; and

(2) No more than 2,615,000 gallons of cutback asphalts shall be used, of which no more than 1,400,000 gallons may be used for dust palliative work on roadways and shoulders; and

(3) No more than 2,500,000 gallons total of emulsion Class E-4 and Class E-5 shall be used unless an equivalent reduction in the use of cutbacks is made to balance the additional hydrocarbon emissions from emulsions.

(b) The Pennsylvania Department of Transportation is required to submit to the Pennsylvania Department of Environmental Resources, on a quarterly basis, reports which list for each of the affected Counties the number of gallons of each class of asphalt used. The first quarterly reports will be submitted in October 1977 for the period between July 1, 1977, and September 30, 1977. Copies of all reports will also be forwarded to Region III, EPA."

4.1.6 SOUTH CAROLINA

4.1.6.1 Bituminous-Materials-Use Table for South Carolina. SCDHPT, the Asphalt Institute, two contractors, and two emulsified asphalt suppliers provided data used to develop the composite bituminous-materials-use table for South Carolina which is presented in Table 16. The road construction and maintenance operations which are exempt under South Carolina's RACT are underscored.

4.1.6.2 Road Construction and Maintenance Operations. South Carolina State Highway Department, Standard Specifications for Highway Construction, 1973 edition, was used as the reference of road construction and maintenance operations used to develop South Carolina's bituminous-materials-use table. Fifteen road construction and maintenance categories were evaluated for South Carolina; these categories and any specified grades of cutback and emulsified asphalts cited in the reference, are listed below. The categories exempt by RACT have been underscored.

	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Road Mix Sand Asphalt Base Course	RC-70,250,800,3000 MC-250,800	SS-1,1h
Cold Laid Asphaltic Concrete Binder Course ^a	RC-250,800,3000 MC-250,800,3000 SC-250,800	
Cold Laid Asphaltic Concrete Surface ^{a,b}		
Bituminous Surfacing (Single Treatment, Types 1,2,3,4, and 5)	RC-800,3000	CRS-2

Table 16

BITUMINOUS-MATERIALS-USE TABLE FOR SOUTH CAROLINA^a

	Pre-RACT Use				Post-RACT Use (Through 1980)			
	Prior to July 1, 1979		Regulated Season from March 1 to November 30		Regulated Season from December 1 to February 28		Nonregulated Season from	
	SCDHPT and AI	Contr. A	Supp. B	Contr. A	SCDHPT and AI	Contr. A	SCDHPT and AI	Supp. B
Road Construction or Maintenance Operation								
Road Mix Sand Asphalt								
Base Course								
Cutback	3	5	5	5	5	5	5	5
Emulsified	5	5	1	5	5	1	5	1
Cold Laid Asphaltic								
Concrete Binder Course								
Cutback	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5
Cold Laid Asphaltic								
Concrete Surface Course								
Cutback	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5
Bituminous Surfacing (Single Treatment, Types 1,2,3,4, and 5)								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	1
Bituminous Surfacing (Double Treatment, Types 1,2,3, and 4)								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	1
Bituminous Surfacing (Triple Treatment, Types 1,2,3,4, and 5)								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	1
Fog Seal								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	1
Prime Coat								
Cutback	5	5	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	1
Emulsified	2	5	3	5	2	3	2	3

Table 16

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use Prior to July 1, 1979				Post-RACT Use (Through 1980)					
	SCDHPT and AI		Contr. A Supp. B		Regulated Season from March 1 to November 30		Nonregulated Season from December 1 to February 28		Supp. A	Supp. B ^a
	5	1	5	1	SCDHPT and AI	Contr. A	SCDHPT and AI	Contr. A		
Tack Coat	5	1	5	1	5	5	5	5	5	5
Cutback	1	1	1	1	1	1	1	1	5	1
Emulsified										
Patch Material										
Immediate Use										
Cutback	2	5	1	5	2	5	2	5	5	5
Emulsified	1	5	1	5	1	5	1	5	5	5
Stockpile										
Cutback	2	5	5	5	2	5	2	5	5	5
Emulsified	1	5	5	5	1	5	1	5	5	5
Paved Shoulders										
Cutback	5	5	5	5	5	5	5	5	5	5
Emulsified	5	f	5	5	4	f	5	f	5	5
Dust Palliative										
Cutback	5	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	1	5	5	5	5	5	1
Aggregate Precoat										
Cutback	5	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5	5	5
Recycling										
Cutback	5	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	5	5	5	5	5	5

^awhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

braving operations conducted during December, January, and February are mainly limited to stabilized aggregate base course, hot laid asphaltic concrete binder course, and hot plant mix seal course (popcorn mix) work.

^cSpecifications on weather will limit the use of these materials.

^dSee patch material: immediate use for the cutback and emulsified asphalt use levels.

^eThe respondent referred to a fog seal material as a crack sealant.

^fSee bituminous surfacing: single treatment for the cutback and emulsified asphalt use levels.

	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Bituminous Surfacing (Double Treatment, Types 1,2,3, and 4)	RC-30,70,250,800,3000 MC-30,70,250,800,3000	RS-1,2 CRS-1,2 MS-1,2,2h CMS-2,2h SS-1,1h CSS-1,1h
Bituminous Surfacing (Triple Treatment, Types 1,2,3,4, and 5)	RC-250,800,3000	RS-2 CRS-2
<u>Fog Seal^C</u> <u>Prime Coat</u>	RC-30 ^d MC-30	EA-P
Tack Coat Patch Material ^C Immediate <u>Stockpile</u> Paved Shoulders ^C Dust Palliative ^C Aggregate Precoat ^C Recycling ^C		

^aThis mix is primarily used as patch material for immediate use and some stockpile storage.

^bSee Cold Laid Asphaltic Concrete Binder Course for material specifications.

^cSCDHPT does not currently have specifications for these operations.

^dPrime coat for Macadam Base Course and Stabilized Aggregate Base Course may also be RC-70.

With the exception of RC-30, RS-2, and EA-P specifications, which can be found in Section 406 of the reference, South Carolina conforms to AASHTO specifications for cutback and emulsified asphalts (see Colorado, Section 4.1.2.1, page 100 for AASHTO Designations).

4.1.6.3 Cutback and Emulsified Asphalt Suppliers Who Serve South Carolina. According to the SCDHPT's Purchasing Department, there are four companies providing cutback or emulsified asphalts for SCDHPT road construction and maintenance work. These companies and their products are listed below.

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Central Oil Asphalt Corp. 8 East Long Street Suite 400 Columbus, OH 43215		RS-2 CRS-2 CMS-2
Exxon Co., U.S.A. P.O. Box 10407 Charleston, SC 29405	RC-30,250 MC-30	
Koch Asphalt Co. P.O. Box 6098 Meeting and Greenleaf Streets Charleston, SC 29405		CRS-2 CMS-2 SS-1
Koch Asphalt Co. P.O. Box 469 Poinsetta Street Greer, SC 29651		CRS-2 CMS-2 SS-1
Seaco, Inc. 2700 Industrial Drive P.O. Box 5227 Columbia, SC 29250		RS-2 CRS-2 CMS-2 SS-1 AE-P

4.1.7 TEXAS

4.1.7.1 Texas Road Construction and Maintenance Operations. The Texas Highway Department 1972 Standard Specifications for Construction of Highways, Streets, and Bridges was used as the reference to develop the bituminous-materials-use table for Texas. Eleven general road construction and maintenance categories were evaluated for the nonattainment areas of Texas. None of these categories, which are listed below, are individually restricted by RACT. The only restriction is that the use of cutback asphalts in a nonattainment area must not exceed eight percent of the total annual

volume of liquid asphalts used or specified for use in that area (averaged over two years).

Stabilization Mixes (Road
and Plant Mixes)
Surface Treatments and Seal Coats
(One, Two, and Three Course
Surface Treatments)
Fog Seal
Prime Coat
Tack Coat

Patching Material:
Immediate Use
Stockpile
Paved Shoulders
Dust Palliative
Aggregate Precoat
Recycling

The only category for which THD specifies a particular type of asphalt is tack coat, where either RC-2 cutback asphalt or EA-11M emulsified asphalt may be used. For all other categories, the grades of cutback and emulsified asphalts are specified by the THD engineer who makes his selection from a general bituminous materials section (Section 300 of the reference).

4.1.7.2 Cutback and Emulsified Asphalt Suppliers Who Serve Texas.

The Texas Highway Department maintains a list of cutback and emulsified asphalt suppliers who furnish bituminous materials for state contracts. The list, which has been provided by THD's Bituminous Materials Laboratory, is reproduced below. Supplemental information has been provided by the Asphalt Institute.

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
American Petrofina Mount Pleasant, TX		X
Chevron-USA, Inc. El Paso, TX	X	X

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Central Oil Asphalt Corp. 8 East Long Street Suite 400 Columbus, OH 43215		RS-2 CRS-2 CMS-2
Exxon Co., U.S.A. P.O. Box 10407 Charleston, SC 29405	RC-30,250 MC-30	
Koch Asphalt Co. P.O. Box 6098 Meeting and Greenleaf Streets Charleston, SC 29405		CRS-2 CMS-2 SS-1
Koch Asphalt Co. P.O. Box 469 Poinsetta Street Greer, SC 29651		CRS-2 CMS-2 SS-1
Seaco, Inc. 2700 Industrial Drive P.O. Box 5227 Columbia, SC 29250		RS-2 CRS-2 CMS-2 SS-1 AE-P

4.1.7 TEXAS

4.1.7.1 Texas Road Construction and Maintenance Operations. The Texas Highway Department 1972 Standard Specifications for Construction of Highways, Streets, and Bridges was used as the reference to develop the bituminous-materials-use table for Texas. Eleven general road construction and maintenance categories were evaluated for the nonattainment areas of Texas. None of these categories, which are listed below, are individually restricted by RACT. The only restriction is that the use of cutback asphalts in a nonattainment area must not exceed eight percent of the total annual

volume of liquid asphalts used or specified for use in that area (averaged over two years).

Stabilization Mixes (Road
and Plant Mixes)
Surface Treatments and Seal Coats
(One, Two, and Three Course
Surface Treatments)
Fog Seal
Prime Coat
Tack Coat

Patching Material:
Immediate Use
Stockpile
Paved Shoulders
Dust Palliative
Aggregate Precoat
Recycling

The only category for which THD specifies a particular type of asphalt is tack coat, where either RC-2 cutback asphalt or EA-11M emulsified asphalt may be used. For all other categories, the grades of cutback and emulsified asphalts are specified by the THD engineer who makes his selection from a general bituminous materials section (Section 300 of the reference).

4.1.7.2 Cutback and Emulsified Asphalt Suppliers Who Serve Texas.

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<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
American Petrofina Mount Pleasant, TX		X
Chevron-USA, Inc. El Paso, TX	X	X

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Codson Oil and Chemical Co. Subsidiary of American Petrofina Big Spring, TX	X	X
Crumbull Asphalt Co. Houston, TX		X
Diamond Shamrock Dumas, TX	X	
Dorchester Refining Co. Mount Pleasant, TX	X	X
Exxon Corp. Baytown, TX	X	
Gulf States Asphalt Co. Houston, TX	X	X
Kerr-McGee Refinery Wynnewood, OK	X	
NuWay Emulsions: Arlington, TX		X
Garland, TX		X
Pleasanton, TX		X
Ardmore, OK		X
Woodward, OK		X
Oklahoma Refining Co. Cyril, OK	X	X
Slurry Seal, Inc. Waco, TX		X
Texaco Refining Co. Port Neches, TX	X	
Texas Emulsions, Inc.: Austion, TX		X
Corpus Christi, TX		X
Port Neches, TX		X
Vickers Petroleum Co. Ardmore, OK	X	

4.1.8 WISCONSIN

4.1.8.1 Bituminous-Materials-Use Table for Wisconsin. WDOT, the Asphalt Institute, two county highway departments, a contractor, and two emulsified asphalt suppliers provided data used to compile the composite bituminous-materials-use table which is presented in two Sections for Wisconsin. Section 1 of Table 17 lists responses from WDOT, the Asphalt Institute, and the two county highway departments. Section 2 of Table 17 lists responses from the paving contractor and two emulsified asphalt suppliers. The road construction and maintenance categories which are presently exempt by RACT are underscored.

4.1.8.2 Wisconsin Road Construction and Maintenance Operations. Fourteen categories of road construction and maintenance operations were evaluated for Wisconsin. WDOT's highway specifications, Standard Specifications for Road and Bridge Construction, 1975 edition, was used as the reference. The categories are listed below; those exempt from RACT are underscored.

Asphalt Stabilized Base Course
Bituminous Road Mix Surface
Plant Mix Bituminous Bases^a
Single Aggregate Bituminous Surface
Seal Coat
Fog Seal
Prime Coat

Tack Coat
Patch Material
Immediate Use
Stockpile
Paved Shoulders
Dust Palliative
Aggregate Precoat
Recycling

According to a January 1980 revision to the 1975 highway specifications, WDOT recommends the use of SC-800 and -3000 or MC-800 and -3000 in

Table 17

BITUMINOUS-MATERIALS-USE TABLE FOR WISCONSIN, SECTION 1: AI, WDOT, AND COUNTIESa

	Pre-RACT Use Prior to May 1, 1980			Post-RACT Use (Through 1980)					
				Regulated Season from May 1 to September 30			Nonregulated Season from October 1 to April 30		
	AI	WDOT	County	AI	WDOT	County	AI	WDOT	County
	A	B	A B	A	B	A B	A	B	A B
Road Construction or Maintenance Operation									
Asphalt Stabilized Base Course									
Cutback	2	2	5	2	5	5	2	5	5
Emulsified	2	3	5	2	5	5	2	5	5
Bituminous Road Mix Surface									
Cutback	1	1	1	5	2	5	2	1	5
Emulsified	2	3	5	2	3	5	2	3	5
Plant Mix Bituminous Base									
Cutback	2	2	5	5	5	5	5	5	5
Emulsified	2	3	5	2	5	5	5	5	5
Single Aggregate Bituminous Surface									
Cutback	1	2	-	5	2	5	5	5	5
Emulsified	5	5	-	1	4	1	5	2	5
Seal Coat									
Cutback	1	1	3	5	5	5	5	5	5
Emulsified	1	1	1	1	1	1	1	2	5
Fog Seal									
Cutback	5	5	5	5	5	5	5	5	5
Emulsified	1	2	5	1	1	5	1	1	5
Bituminous Prime Coat									
Cutback	1	1	5	1	5	5	1	5	5
Emulsified	5	2	5	5	1	5	5	5	5
Bituminous Tack Coat									
Cutback	2	1	5	5	5	5	5	5	5
Emulsified	5	2	5	1	2	5	1	2	5
Bituminous Patch Material									
Immediate Use									
Cutback	1	1	1	1	2	1	1	2	1
Emulsified	5	3	5	5	2	5	5	2	5
Stockpile									
Cutback	1	1	1	1	1	1	1	1	1
Emulsified	5	3	5	5	2	5	5	3	5

Table 17, Section 1

(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use						Post-RACT Use (Through 1980)					
	Prior to May 1, 1980						Regulated Season from May 1 to September 30			Nonregulated Season from October 1 to April 30		
	County		County		County		County		County		County	
	AI	WDOT	A	B	AI	WDOT	A	B	AI	WDOT	A	B
Paved Shoulders												
Cutback	5	2	5	1	5	5	5	1	5	5	5	1
Emulsified	2	5	5	5	2	2	5	5	2	2	5	5
Dust Palliative												
Cutback	5	5	5	2	5	5	5	2	5	5	5	2
Emulsified	5	5	5	2	2	5	5	2	2	5	5	2
Aggregate Precoat												
Cutback	5	5	5	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	2	5	5	5	5	5	5	5
Recycling												
Cutback	1	2	5	5	5	5	5	5	5	5	5	5
Emulsified	5	5	5	5	2	4	5	5	2	4	5	5

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

Table 17

BITUMINOUS-MATERIALS-USE TABLE FOR WISCONSIN, SECTION 2: CONTRACTORS AND SUPPLIERS^a

	Pre-RACT Use		Post-RACT Use (Through 1980)			
	Prior to May 1, 1980		Regulated Season		Nonregulated Season	
	Contr.	Supp.	Contr.	Supp.	from May 1 to September 30	from October 1 to April 30
Road Construction or Maintenance Operation						
Asphalt Stabilized Base Course						
Cutback	1	2	1	2	1	-
Emulsified	2	5	2	3	2	-
Bituminous Road Mix Surface						
Cutback	1	1	1	2	1	-
Emulsified	5	3	2	2	5	-
Plant Mix Bituminous Base						
Cutback	2	1	2	2	2	-
Emulsified	3	3	3	2	5	-
Single Aggregate Bituminous Surface						
Cutback	2	2	2	5	2	5
Emulsified	3	2	3	5	5	5
Seal Coat						
Cutback	1	1	1	3	1	1
Emulsified	2	1	2	1	5	5
Fog Seal	1	2	1	5	1	5
Cutback	2	1	2	1	5	5
Emulsified						
Bituminous Prime Coat						
Cutback	1	1	1	2	1	1
Emulsified	5	3	5	2	5	3
Bituminous Tack Coat						
Cutback	1	1	1	5	1	1
Emulsified	2	1	2	1	2	1
Bituminous Patch Material						
Immediate Use						
Cutback	1	1	1	1	1	1
Emulsified	3	3	3	2	5	3
Stockpile						
Cutback	1	1	1	1	1	1
Emulsified	5	3	5	2	5	3

Table 17, Section 2
(Continued)

Road Construction or Maintenance Operation	Pre-RACT Use				Post-RACT Use (Through 1980)			
	Prior to May 1, 1980		Regulated Season		Nonregulated Season		from October 1	
	Contr.	Supp.	Contr.	Supp.	Contr.	Supp.	to April 30	Supp.
Paved Shoulders								
Cutback	2	5	2	5	2	5	2	5
Emulsified	2	5	2	5	2	5	2	5
Dust Palliative								
Cutback	1	1	1	1	1	1	1	1
Emulsified	2	2	2	2	2	2	5	3
Aggregate Precoat								
Cutback	1	5	1	5	1	5	1	5
Emulsified	3	5	3	5	3	5	5	5
Recycling								
Cutback	1	5	1	5	1	5	1	5
Emulsified	2	5	2	5	2	5	5	5

aWhere 1 = generally used

2 = sometimes used

3 = used on a selected or trial basis

4 = currently not used but in research and development stage

5 = never used.

single aggregate bituminous surfaces. Grades of cutback and emulsified asphalts are usually not specified for the other operations; instead, the user is referred to a general bituminous materials section where he is instructed to comply with AASHTO specifications (see Colorado, Section 4.1.2.1, page 100 for AASHTO Designations). There is one property deviation from AASHTO specifications for cutback asphalts that WDOT permits. This involves Kinematic viscosity (centistokes at 140 F (60 C)). WDOT permits a wider range in viscosity for all cutback asphalts than AASHTO. As an example, AASHTO specifies a minimum viscosity of 30 and a maximum viscosity of 60 for MC-30, whereas WDOT specifies a 25 to 70 range.

4.1.8.3 Cutback and Emulsified Asphalt Suppliers Who Serve Wisconsin. WDOT requested bids for cutback and emulsified asphalts for use in the 1980 construction year. In response, the companies listed below submitted bids for the following grades of cutback and emulsified asphalts:

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Asphalt Products Co. 741 Mason Street P.O. Box 74 Stevens Point, WI 54481	SC-250,800	RS-2 CRS-2
Asphalt Petroleum Co. Division of Asland Oil, Inc. P.O. Box 9 5 W. Broadway St. Paul Park, MN	SC-250,800 MC-250,800, 3000 RC-800	CRS-2
Conoco, Inc. 8475 North 54th Street Brown Deer, WI 53223	SC-15000	

<u>Company</u>	<u>Cutback Asphalts</u>	<u>Emulsified Asphalts</u>
Koch Asphalt Co. Division of Koch Fuels, Inc. P.O. Box 43596 St. Paul, MN 55164	SC-250,800,3000, 15000 MC-250,800,3000 RC-800	RS-2 CRS-2
Murphy Oil Co. P.O. Box 2066 Superior, WI 54880	SC-250,800,3000, 15000 MC-250,800,3000 RC-800	
Seneca Petroleum Co., Inc. 3258 S. Canal Street Chicago, IL 60616		RS-2

There are also three other emulsified asphalt suppliers located in Wisconsin according to a 1979 update of Emulsion Plants in the United States, Canada, and Mexico, compiled by the Asphalt Emulsion Manufacturers Association (AEMA), 1977. They include:

Henry G. Meigs, Inc. 5th 33rd and Superior Street Portage, WI 53901	Koppers Company, Inc. 6870 S. 13th Street Oak Creek, WI 53154	Struck and Irwin Inc. 826 Williamson Street Madison, WI 53793
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4.2 Appendix B

4.2.1 Ranges of Mean Monthly Temperatures, Relative Humidities, and Rainfall for States Not Evaluated in This Study

Based on Status Summary of State Group I VOC RACT Regulations, May 1980 (GCA Corp., Bedford, Massachusetts), nineteen states, in addition to California, Colorado, Indiana, Missouri, Pennsylvania, South Carolina, Texas, and Wisconsin, presently have RACT for the use of cutback asphalts in road construction and maintenance operations. For each of these additional states, the ranges of mean monthly temperatures, relative humidities, and rainfall during the months in which RACT is being (or is to be) implemented have been given in Table 18. This information has been provided in the event the reader wishes to compare the general climatic conditions in the states not evaluated in this study to those in the states which were evaluated.

Table 18

RANGES IN MEAN MONTHLY TEMPERATURES, RELATIVE HUMIDITIES, AND RAINFALL FOR THE MONTHS IN WHICH RACT IS BEING (OR IS TO BE) IMPLEMENTED*

State	January	February	March	Months in Which RACT is Being (Or Is To Be) Implemented								
				April	May	June	July	August	September	October	November	December
Alabama												
Temp (°F)			49-62	59-70	68-75	75-81	78-82	76-82	71-80	61-71		
Rel. Hum. (%)			65-72	63-71	68-72	69-75	72-81	73-80	71-78	68-75		
Rainfall (in)				4.27-6.03	3.37-4.98	3.48-5.72	4.50-9.33	3.49-6.35	2.77-5.68	1.85-2.81		
Delaware												
Temp (°F)					60-63	68-71	76-78	74-76	67-69			
Rel. Hum. (%)					69-71	70-72	69-78	70-78	70-76			
Rainfall (in)					4.10-4.22	3.59-3.90	4.17-4.49	5.34-5.74	3.27-4.13			
Florida												
Temp (°F)	54-70	54-70	60-72	68-75	74-79	78-81	81-83	81-83	78-82	68-77	58-72	54-70
Rel. Hum. (%)	77-81	71-78	70-77	68-74	68-75	73-76	78-81	77-81	78-83	76-82	74-80	77-81
Rainfall (in)	1.49-3.86	0.86-4.00	1.86-5.51	2.41-4.78	2.50-5.18	4.49-7.47	4.69-8.16	4.69-7.58	5.46-9.23	2.16-8.36	1.52-3.57	1.25-5.40
Georgia												
Temp (°F)	39-56	40-57	45-63	54-68	64-74	68-81	69-83	68-82	64-78	55-70	45-60	39-56
Rel. Hum. (%)	68-78	67-72	68-72	59-71	69-74	67-72	74-80	75-80	74-80	68-79	67-74	70-78
Rainfall (in)	2.50-5.49	2.93-4.98	3.64-5.96	3.01-4.66	3.13-3.74	3.68-5.00	4.74-6.78	4.13-6.46	2.90-6.61	1.82-3.16	1.78-3.53	2.87-5.33
Illinois												
Temp (°F)					57-67	68-76	74-81	72-78	64-72			
Rel. Hum. (%)					66-68	68-73	65-69	72-75	68-71			
Rainfall (in)					3.77-4.24	3.82-4.87	3.04-3.53	3.09-3.77	2.88-3.50			
Kentucky												
Temp (°F)				53-58	63-67	69-77	70-83	70-79	67-72	57-61		
Rel. Hum. (%)				62-65	66-69	68-73	66-78	69-79	67-77	67-73		
Rainfall (in)				3.66-4.19	3.78-3.94	3.79-4.24	3.63-4.77	3.32-4.00	2.74-3.22	2.16-2.66		
Louisiana												
Temp (°F)	47-56	49-57	56-63	64-68	72-76	78-81	81-83	82-83	77-81	66-72	54-65	48-57
Rel. Hum. (%)	74-81	72-78	68-73	68-78	73-78	72-77	69-82	67-81	68-80	67-75	67-74	69-81
Rainfall (in)	4.43-6.24	4.36-5.17	4.22-6.39	4.59-5.46	4.53-6.41	2.61-5.37	4.14-8.00	2.82-6.71	2.27-6.30	2.28-2.86	4.23-4.54	5.02-6.03
Massachusetts												
Temp (°F)					52-55	60-65	65-73	64-71	55-65			
Rel. Hum. (%)					63-80	70-80	69-81	73-80	76-80			
Rainfall (in)					3.29-4.20	3.26-4.17	2.63-4.36	3.82-4.03	3.72-4.33			
Michigan												
Temp (°F)					48-58	54-70	64-73	63-72				
Rel. Hum. (%)					68-72	68-74	68-75	69-80				
Rainfall (in)					2.79-3.84	3.16-4.38	2.43-3.55	2.69-3.61				
New Hampshire												
Temp (°F)						55-66	63-72	63-71	54-62			
Rel. Hum. (%)						64-70	68-72	70-81	78-80			
Rainfall (in)						3.72-4.45	3.70-4.25	3.33-3.80	3.76-4.21			
New Jersey												
Temp (°F)				46-51	57-62	66-73	71-76	69-76	63-68	53-57		
Rel. Hum. (%)				64-71	67-73	68-73	67-74	68-74	67-76	69-74		
Rainfall (in)				3.25-3.78	3.37-4.29	3.17-4.16	3.41-4.62	4.91-5.20	3.74-4.03	3.10-3.31		
New York												
Temp (°F)					48-61	57-68	64-72	63-74	54-62	44-52		
Rel. Hum. (%)					64-72	68-73	66-73	70-80	73-78	71-76		
Rainfall (in)					3.11-4.01	2.74-3.98	2.91-4.28	2.82-4.05	2.72-4.15	2.82-3.71		
North Carolina												
Temp (°F)	34-48	35-49	39-54	51-63	58-71	63-75	69-81	69-80	64-76	54-66	43-56	35-48
Rel. Hum. (%)	68-81	67-72	59-72	68-71	69-73	67-73	69-81	75-81	75-82	67-81	68-73	68-80
Rainfall (in)	3.05-4.96	3.18-4.46	3.67-5.68	3.23-4.09	3.29-4.29	3.70-4.56	5.26-7.10	5.05-6.37	3.43-5.28	2.50-3.41	2.76-3.48	3.23-4.79
Ohio												
Temp (°F)				46-55	58-66	67-73	71-77	69-75	63-68	52-57		
Rel. Hum. (%)				68-71	67-70	70-73	67-71	68-73	68-74	68-73		
Rainfall (in)				3.14-3.69	3.45-3.91	3.57-4.28	3.14-4.17	2.72-3.77	2.80-3.05	2.09-2.80		
Oklahoma												
Temp (°F)					60-71	74-81	74-86	76-86	69-76			
Rel. Hum. (%)					58-73	52-71	53-67	53-66	53-65			
Rainfall (in)					3.17-6.03	2.56-5.07	2.00-3.70	2.22-3.22	1.53-4.22			
Oregon												
Temp (°F)				39-52	44-53	49-66	59-72	55-71	49-62	43-53		
Rel. Hum. (%)				49-81	59-80	45-81	39-83	32-82	39-82	54-71		
Rainfall (in)				0.82-4.91	0.97-4.04	0.99-3.23	0.23-0.78	0.18-0.86	0.37-2.21	0.68-6.59		
Tennessee												
Temp (°F)	38-43	38-44	42-52	52-62	64-71	68-76	70-82	70-81	65-74	54-63	44-52	36-43
Rel. Hum. (%)	71-77	69-76	64-70	61-65	69-74	67-72	68-72	73-78	68-76	68-73	68-73	73-76
Rainfall (in)	4.87-6.19	4.55-5.65	5.20-5.90	3.74-4.30	3.77-4.08	3.61-4.23	4.00-5.56	3.07-4.23	2.72-3.32	2.55-2.88	3.15-4.09	4.23-5.32
Virginia												
Temp (°F)				49-60	59-67	64-77	65-79	64-77	61-73	50-62		
Rel. Hum. (%)				59-71	68-73	68-77	67-80	76-81	70-80	71-79		
Rainfall (in)				3.00-3.54	3.58-4.26	3.59-4.27	4.19-5.31	4.40-5.31	2.83-3.83	2.41-3.30		
Washington												
Temp (°F)						48-62	54-72	54-73	49-63			
Rel. Hum. (%)						47-82	37-91	38-93	46-82			
Rainfall (in)						6.97-3.91	0.20-2.09	0.21-1.98	0.44-4.31			

*This information has been interpolated from figures on maps in the Climate Atlas of the United States, U.S. Department of Commerce, 1968.

4.3 Appendix C

4.3.1 Glossary of Road Construction and Maintenance Operations.

Aggregate

Open Graded: A mix of aggregate which contains little or no mineral filler, characterized by relatively large void spaces when compacted.

Dense-Graded: A mix of aggregate which is graded from the maximum size down through mineral filler, characterized by relatively small void spaces when compacted making the mix stable.

Sand: Aggregate which passes the 2.36 mm. sieve (No. 8).

Aggregate and Asphalt Mixtures

Cold-Laid Plant Mix: A mixture of aggregate and asphalt prepared at a central mixing plant and spread and compacted at the job site at or near ambient temperature.

Mixed-In-Place Mix (Road Mix): A mixture of aggregate and asphalt prepared at the job site on the road surface by portable mixing equipment.

Patch Material: A maintenance mixture of aggregate and asphalt usually prepared at a central mixing plant for storage or immediate use in filling potholes or other minor road failures.

Slurry Seal: A mixture of emulsified asphalt, dense-graded fine aggregate, mineral filler, and water used to fill cracks and restore or seal existing road surfaces.

Aggregate and Asphalt Spray Applications

Single Surface Treatment: A single application of asphalt to the road surface followed immediately by a single layer of aggregate with the application having a thickness close to the nominal maximum size of the aggregate particles.

Multiple Surface Treatment: Two or more applications of aggregate and asphalt with the maximum size of aggregate in each successive treatment about one-half that of the previous one.

Penetration Macadam: One or more applications of aggregate and asphalt in which one application consists of a one-size course aggregate penetrated with a viscous asphalt followed by smaller one-size course aggregate.

Asphalt Spray Applications

Fog Seal: A light spray application of diluted emulsified asphalt used in crack sealing and light maintenance (such as renewing old surfaces).

Prime Coat: A spray application of highly penetrating low-viscosity asphalt used to prepare an untreated base (or sub-base) for an asphalt course. The prime coat penetrates into the base forming a water resistant layer on its surface, hardens and stabilizes the surface, and helps bind it to the following asphalt course.

Tack Coat: A spray application of a low-viscosity asphalt used to provide adhesion between two asphalt courses.